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ALTERNATING STATIONS AND POWER SUPPLY.

ONE of the stock arguments against alternating supply has been the assertion that motive power could not be provided with any chance of success. It is hardly necessary to deal at length with this argument at the present time, because it has been proved that single-phase alternating motors are on the market which can be effectively employed for most of the purposes to which electric motors of moderate size are adapted.

Engineers know perfectly well that the objection to motors as a day load on a small station, or one with a small day load to which motors are added, is the difficulty of maintaining the pressure within reasonable limits of variation from the declared normal.

As Mr. Baynes pointed out some years ago, one has to consider neither the plant installed nor the evening maximum load, but the percentage variation in load during the day, which the throwing on and off of individual motors may create. In an alternating station it is obvious that mere engine governing, however perfect, cannot compensate for the load changes unless the alternator characteristic be very flat with a given exciting current. It is the exception rather than the rule to find special attention paid to switchboard regulation during daylight hours, and as motors are usually run during this period the benefit derived financially from a motor load has to be discounted by so much as is entailed by additional staff and attendance.

The aspect of the question presented to the American engineer is rather different, as may be judged by perusal of an article by Mr. T. M. Meston in a recent issue of a trans-Atlantic contemporary. We refer to this because it is a good illustration of the views held by those who are strong advocates of the motor as a revenue-yielding device. The argument runs as follows:—The most interesting problem connected with station management is the increasing of the net revenue, and any policy tending to give a larger gross revenue that does not at the same time add to the upkeep or operating expenses in the same proportion, must result in a gain in net profit. The standing charges of a station are principally charges on the capital outlay in the form of redemption, sinking fund, depreciation, and the like; rent, rates and taxes, salaries and wages, so far as they are necessarily incurred in maintaining the system in a state of preparedness to supply, and upkeep, &c., of the distributing system. These items cannot, under reasonably efficient management, be reduced by altering the method of running, nor are they augmented by increasing the classes of consuming devices supplied. Mr. Meston then deals with the case where a plant has been shut down in the day, and proceeds to show that by encouraging a motor load, a remunerative day service can be inaugurated. Like numerous advocates of cheap day supply, he cites clothing factories, family sewing

machines, dentists, lathes, jewellers, doctors (for operating Holtz machines), coffee mills, forge blowers, organ blowers for churches, pumps for houses where water supply is taken from wells, as likely sources of revenue. We are afraid that the aggregate return from these would be trifling compared with expectations. In this country, at least, the only serious consumers of electric energy for power purposes are lifts, workshop and warehouse motors to supplant gas engines, and the like. A fatherly Board of Trade insists upon many things, amongst them being the proviso that the supply shall be uninterrupted. Therefore, machinery has to be kept constantly at work, and most of the smaller stations have what is termed a "day plant," ranging from 40 kilowatts downwards to a toy of 10 kilowatts. One can hardly imagine that a host of coffee mills or sewing machines would overtax the power of even the smallest of these small sets, and our friends who are "hustlers" as well as station managers might find something to assist their "net revenue account" by encouraging such humble but useful users of power.

There is, however, another side to the question, and we should have thought space better employed on other subjects had it not been that this side must soon receive attention from many engineers, while even at present a few have had to look into it. An example will most readily show the importance of the question. A central station may be asked to supply power for, say, electric welding—work which requires large power for a very short period of time, and therefore causes variations in the station load of considerable magnitude at short intervals. Such a consumer cannot, on the face of it, be desirable. With motors only the first few give much trouble; when a large number are connected it is most unlikely that many will be started simultaneously and the individual variations cancel out mutually. But it is difficult to see how single large consumers can be compensated by other consumers. This is a particular case of the general problem that has so far been met with in only a few districts, the provision of outside reserve or stand-by to theatres and other places generally operating their own private plants. Apart from the commercial aspect, there is the technical difficulty of providing mains and sub-station plant and of running at such pressures that the sudden acquisition of load by a particular section of distributor shall not injuriously affect the supply to the consumers who constitute the normal load thereon, when, perhaps, the abnormal load has not been met with for months, and maybe years. We have confined our remarks to alternating systems. Continuous current systems are undoubtedly better able to cope with the change, inasmuch as it is customary to run with large networked distributors fed by several feeders, and there is no intermediate apparatus similar to transformers entering into the argument.

We certainly think that more might be made of small motors. As time goes on prices will fall, and the charge for power or day supply will be reduced. Small motors in the aggregate may then be worth something, and the difficulties of supply will disappear as the number increases. The one thing that station engineers, however, find fault with is the starting current of even the best single-phase motors on the market. We may look forward to the time when Board of Trade inspections will have to be faced, and testing stations established. When that day comes, we sympathise with the woes of some engineers whose circuits are lightly loaded in the day time, but whose *clientèle* includes a few users of medium-sized motors. The erratic character of motor load is its drawback, and we shall doubtless see other systems following the County of London Company in preferring 500-volt continuous for power supply, thus keeping alternating for lighting only.

Electrolytic Conductivity of Salt Solutions.—R. Goldschmidt and A. Reychler have devised an apparatus of small capacity, by which electrolytic conductivities may be taken by the method of Kohlrausch. One of the electrodes is permanently fixed at the bottom of an ebonite cup, and is connected to a binding screw by a wire passing through the ebonite; the other is attached to a micrometer screw protected at the lower extremity by an ebonite sheath. The distance between the electrodes may be read to about 0·01 mm. by means of the divided head of the screw. The first apparatus, with electrodes of 9·4 mm. diameter, in a cup of 15·5 mm. in diameter, did not give a sufficiently clear sound in the telephone when the electrodes were 3 mm. or more apart. The second apparatus employed, with electrodes of 14·3 and 40 mm. diameter, in cups of 17·3 and 47 mm. diameter, respectively, gave satisfactory results under certain conditions. The specific conductivity of $\frac{1}{500}$ N — potassium chloride solution was calculated from the observed resistances, R and R^1, of $\frac{1}{50}$ N — and $\frac{1}{5000}$ N — potassium chloride solutions, taking Kohlrausch's figure for the conductivity of the former solution,

$$\text{sp. cond.} = \frac{R}{R^1} \times 0{\cdot}002244,$$

The figures obtained decreased regularly as the distance between the electrodes increased (after the distance of 3 mm., below which the results are irregular). Satisfactorily constant results were obtained when resistances R_m and R^1_m, R_n and R^1_n were measured, for the distances, m and n, between the electrodes. Then

$$\text{sp. cond.} = \frac{R_m - R_n}{R^1_m - R^1_n} \times 0{\cdot}002244.$$

This apparatus might be employed to determine conductivities by a method the inverse of the ordinary. The resistance of a standard solution being measured for different distances of the electrodes, the condition of silence in the telephone, using solution of unknown conductivity, can be effected by movement of the micrometer screw, the movable contact on the bridge remaining at the centre of the wire. The above is an abstract of a paper in the *Bull. Soc. Chim.*, 1898, 19, (15), 675—684.

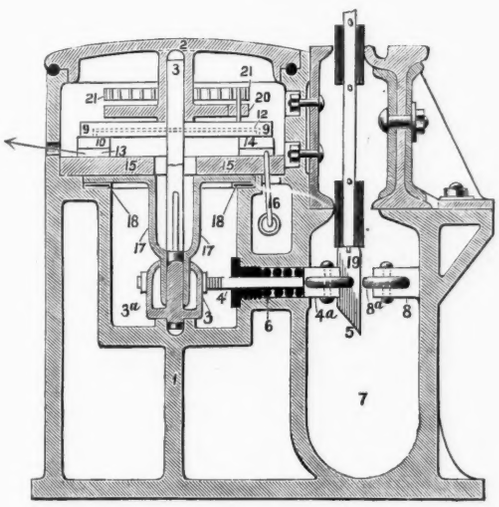
Balancing the Distribution of Current in Multiple-Wound Armatures.—A practical instance of the value of the system of equalising the output of the various sections of a parallel-wound multipolar armature, designed by Mr. B. G. Lamme, and described in the New York *Electrical World*, has been given by the accidental errors in connecting up some large electrolytic generators. One such machine, says our contemporary, was operated with one of the shunt exciting coils reversed for two years before the mistake was discovered, the armature cross connections passing currents which gave an armature reaction sufficient to build up the needed field. An 810-kw. 180-volt 4,500-ampere generator was operated continuously for three weeks with two coils reversed, very little difference in the performance being noted when the mistake was corrected. A further advantage of this system not noted in the original article is that the balancing of the field not only equalises the distribution of the current, but equalises the magnetic pull around the armature, which, in the case of large engine-type machines, is so great that if unbalanced it is likely to wreck some part of the apparatus. Machines with cross-connected coils can be run with the armature iron practically touching the pole pieces on one side and double the normal gap on the other, with very little tendency to cling to the near poles.

COMBINED CONDUIT AND SURFACE CONTACT SYSTEM.

A system which claims to possess the merits of the conduit and surface method has lately been patented by Messrs. Stendebach and Linker, whose interests in this country are represented by Messrs. Estler Bros.

It embraces a combination of the open conduit with contact studs in the centre of the track, in which, however, the conduit serves solely for the purpose of admitting the contact closer in connection with the contact apparatus and for drainage, or, as in the later form the contacts may be placed contiguous to the conduit.

The construction of the later form of conduit is as follows:—The cast-iron box, in which is carried the mechanism, is partly rectangular and partly cylindrical. The cylindrical part of the box is fitted with a cover, 2, flush with the surface of the street. Inside this cylindrical portion, a bar, 3, is arranged, consisting of two parts, the bottom of the lower portion forming a pan-like flange. The lower end of the bar, 3, rests in a socket of a web of the box, 1, while the upper end fits in a socket of the cover, 2. The pan-like part of the bar, 3, is fitted with a toothed wheel, 3A, engaged in a rack, 4. The end of this rack, 4, which



projects into the conduit, 7, has a widened head, 4A, with a roller, 5, and this is pressed outwards by the spring, 6. Opposite to the roller, 5, in the conduit, a bracket, 8, carries a second roller, 8A. The bar, 3, is fitted on its upper end with a disc, 9, of insulating material to which the contacts, 10 and 11, are fixed and connected together by a wire, 12, embedded in the disc, 9. The bar, 3, is encased by the small cylinder, 17, which is screwed on to the box, 1, and the lower part of which rests in the pan-like part of the bar, 3, and this is filled with mercury to exclude moisture from the space containing the contacts, while the upper end of the cylinder, 17, is made air-tight by means of the India-rubber ring, 18.

If the contact closer fitted to the car now passes through the conduit between the rollers, 5 and 8A, the rack, 4, is forced into the box, 1, and this imparts a circular motion to the bar, 3, which in turn causes the disc, 9, to revolve, bringing the contacts, 10 and 11, and the counter contacts, 13 and 14, respectively, together. The contact, 14, is joined to the feeder cable, 16, while from 13 the current is led to the contact studs in the centre of the track from which the current is taken up by the motor car in the manner described above. As soon as the contact closer passes the roller, 5, this is set free, and the rack, 4, is pressed back to its original position by means of the spring, 6, which is reinforced by the spiral spring, 21, fitted in the cover, 2, on a pin, 20, of the disc, 9. Instead of the springs counterweights could be used.

SOME GENERAL OBSERVATIONS ON ELECTRIC TRACTION.*

By HORACE F. PARSHALL, M.I.C.E., M.I.E.E.

A general paper on electric traction must be to some extent discursive, and from the standpoint of those looking for specific facts, superficial.

It is a natural thing for engineers to reason from experience with electric lighting plant, as to how best to design plants suitable for electric traction purposes. Such reasoning, however, is likely to be defective and lead to wrong results. A primary difference between electric lighting and electric traction, so far as the station is concerned, relates to the difference in the nature of the load—one being approximately constant from moment to moment, and the other varying between wide limits, and at such a rate that many engineers liken the strains upon traction apparatus to those upon rolling mill engines. Another difference of great importance is, that in a plant of given nominal horse-power, from three to five times the quantity of electricity would be generated for traction as for lighting purposes; consequently a greater capital investment, greater refinement in the machinery, and greater margins in the individual machines, or in the number of spare machines, are commercially permissible in the case of electric traction. In general, lighting machinery is called upon to work at full load for a few hours in the day, whereas traction machinery is generally called upon to work at approximately full load for many hours in the day.

The steam-generating plant for either lighting or traction of the same capacity need not differ in character to be equally efficient. Having reference, however, to the better load factor of the traction plant, and consequently a greater consumption of coal and a lesser ratio of cost of labour to that of material, better arrangements as to coal-handling machinery and coal storage are justified. More elaborate arrangements of steam piping are also justified, since the loss, due to condensation in steam pipes, is determined by the number of hours the pipes are under pressure rather than by the quantity of steam carried by them.

Steam engines have been the subject of frequent discussions. It has been a much-debated point as to whether or not an engine should have a heavy fly-wheel. This question resolves itself into the most economical way, average loads considered, of getting the maximum effort from the steam engine to take care of the temporary overloading incident to traction work.

The dimensions of the cylinders of engines for good economy are determined with reference to average loads. For best economy, then, at good regulation, heavy fly-wheels are necessary to assist in overloads in traction work. The question of governing has also been frequently discussed. I do not understand why this question should be discussed, since nobody is of the opinion that an engine that governs closely is at a disadvantage. Such engines do not cost appreciably more, and are now generally manufactured. In reading such discussions I have frequently wondered why the electrical conditions met with in parallel running have not been taken into consideration. The necessity of close regulation of steam engines was first demonstrated in the case of generators running in parallel, where the load did not properly divide with rapidly varying loads unless the engines governed with fair accuracy.

Another matter frequently discussed is that in respect to the speed of engines. Here, also, the electrician is entitled to some voice, since experience has clearly demonstrated that each size of dynamo has a range of speed through which its performance either as to efficiency, regulation, or sparking is best, and dynamos built outside of this range of speed are made at the expense of efficiency, regulation, or commutation.

The speed of the 1,500 kw. dynamos which I designed some years ago was limited to 75 revolutions per minute. Experience since then has not demonstrated the advisability of increasing the speed beyond this, for this size of machine. My own experience justifies the statement that the mechanical and electrical conditions in the case of the larger direct connected generators, generally coincide in the matter of speed.

The system of transmitting mains for distribution, on account of the better load factor in traction installations should be designed, for most economical working, with a greater cross section than in the case of lighting with its smaller load factor. This is obvious from Lord Kelvin's law, in which the interest that goes on perpetually is balanced against the cost of the energy wasted in the mains. Clearly then as the cost of energy does not vary in the simple ratio of load factor if mains *are* to be utilised three or four times as many hours in the year at rated capacity in one case as in another, a large cross section cable is required if the cost of the wasted energy is to balance the interest account.

Apart from the proper designing of a given system of transmission and distribution, there remains the broad question as to what will be the nature of the transmission, that is, whether continuous currents shall be used or whether the distribution shall be multiphase with sub-stations. The solution is to be determined in respect to the amount of power and the distance to which it is to be transmitted, and in particular cases to the conditions of distribution. Thus, where a very small voltage drop is permissible in the consumer's circuits, as in the case of earth returns, multiphase transmission with frequent sub-stations becomes a necessity, where under less

* Paper read before the Northern Society of Electrical Engineers, Tuesday, January 24th, 1899.

restricted conditions continuous current transmission would be more economical.

For comparison between continuous current high tension transmission and multiphase transmission, see *Proceedings Institution Civil Engineers*, Vol. cxxxiii., Paper No. 3,090.

It appears from this that the distance at which multiphase currents become efficient as compared with continuous currents at 500 volts, is somewhat less than has been frequently anticipated.

The fixed losses in a multiphase system for the distribution of power for traction work are determined largely by the maximum momentary load which may come upon the sub-stations. When the ratio of the average to the maximum temporary load is comparatively large, the distance at which continuous currents become more efficient than multiphase currents is increased. In very large traction installations, in which the ratio of the average to the maximum approaches unity for average working, the distance at which high tension currents are more advantageous is lessened. What method of transmission will be most efficient in a particular case cannot be determined without knowledge as to the nature of the load. In the Dublin installation, which I have recently designed for 250 cars, the power station is approximately in the centre of the system. The average distance of transmission is about 2½ miles. I have used 500 volts continuous current with so-called "boosting machines," taking the current out of the rails at certain points so as to restrict the maximum drop in the earth to 2 or 3 volts. For two lines, extending some eight miles from the power station, I have, at a distance of about six miles, planned to instal a rotary converter station. The multiphase load, however, being such a small fraction of the whole, I have not installed multiphase generating machines in the station, but have used a special design of rotary converter run from the continuous current machines. Such rotaries have to be very specially designed, since, in the case of the current becoming displaced in phase, they are apt to race dangerously. This is a particular case, designed after determining the average current consumption in any part of the system, when the ratio between the average and the maximum is approximately known from experience, so as to impose the minimum fixed losses, or, in other words, to insure, under average conditions, maximum efficiency. Were the number of cars doubled I would locate sub-stations approximately at the feeding-in points, and would use multiphase transmission.

An advantage in the use of rotary converter stations is, that at constant speeds such machines will give constant voltage regardless of the load or the drop in the lines (provided this be limited to an economical amount), or the regulation in the transformers, so that such machines can be made to supply simultaneously and satisfactorily both traction and lighting installations. To justify this statement I instance tests recently made on some 900 kw. rotary converters from which full load could be thrown on or off from one to the other machine without any perceptible variation of the continuous current voltage.

In the designing of a multiphase system selection has to be made between quarter and three-phase. The three-phase system has the important advantage that but three-quarters of the weight of copper is required, as with either single or quarter-phase transmission. Considered, therefore, with the energy factors common in multiphase working, the three-phase system gives better transmission efficiency with the same section of copper in the average case as continuous current.

Another advantage is gained when the transformers are delta connected. Any one of the three can fail, and the other two will deliver phase currents to the rotaries. There is practically no difference as to efficiency or working between tri-phase and quarter-phase rotary converters. In installations making general use of rotary converters feeding into a network at constant voltage, it is necessary to observe some care in selecting the high tension mains, and in securing engines with approximately constant angular velocity. An engine, to be entirely satisfactory, should not produce by variable velocity a phase displacement of more than 5° per half cycle from that of constant velocity. The transmitting mains should be designed with comparatively small drop, so that the rotary converters work properly in parallel in different stations, and so that the rotary converters can generate constant voltage with a varying load, without too great phase displacement. If proper precautions are not taken in these matters, rotary converters will not operate satisfactorily in parallel, and are likely to give a great amount of trouble from sparking and irregular variation of voltage.

For working with "rotaries," I would also point out the necessity of arranging the mains so that the current in each phase is delivered approximately at the same voltage. I have recently been conducting some tests on "rotaries" working on triple concentric mains. At first the current in the different phases varied by about 10 per cent., and the rotaries worked unsatisfactorily; when, however, the E.M.Fs. were equalised, the rotaries worked with entire satisfaction. The conclusion to be drawn from this, for three-phase working, is that the cables should have equal inductance, equal capacity, and equal resistance in each circuit.

In installations which I have designed I have used cables drawn in conduits, and with manholes approximately 100 yards apart, so that the cables can be readily replaced or supplemented to meet the demands of the service. Armoured cables laid in a common trench are objectionable, in that the burning out of one is quite likely to destroy its neighbour.

By far the most difficult problem to solve at the present moment in large multiphase stations is in connection with the switching apparatus. Circuit breakers have been devised for continuous currents that will open at any current to be met with in practice. In the case of alternating currents the same perfection has not been made. I recently examined the plans of a 70,000-H.P. station, and could not but feel that the success of the whole installation was dependent upon the switching arrangements.

In this discussion I have assumed that the distribution in a traction system would be by continuous currents. I have seen nothing that would lead me to believe that any other system will come into general use.

The next point for consideration is as to what form of apparatus should be used for conducting the electricity from the distributing mains to the car; whether it should be the single wire overhead trolley system with earth return, the two-wire system with return overhead, or with this last connected up as a three-wire system with the middle pair of trolley wires acting as a neutral, or whether a conduit system should be used. The valid objection to the single overhead trolley system, neglecting the æsthetic one, is in the use of the earth as a return circuit. Troubles from electrolysis have been frequent in the United States where the E.M.F. drop in the earth return is not limited by legislation. Owing to the stringent regulations of the Board of Trade, little trouble has yet been experienced in England or on the Continent where similar regulations are in force. I pointed out in a paper which I read before the Institution of Electrical Engineers, that with even very small E.M.Fs. a certain percentage of the current in all cases leaves the rails. With amounts of copper commercially permissible, either sub-stations at frequent intervals or boosting machines such as have already been described by Major Cardew and myself at the Institution of Electrical Engineers are necessary to bring the E.M.F. drop down to two or three volts, which in most cases of municipal working is the safe limit. If the E.M.F. exceeds this limit, trouble from electrolysis will probably occur at some date more or less remote, according to the local conditions as to the location of the earth return in respect to the gas and water pipes and the nature of the soil.

The double overhead trolley system eliminates the possibility of trouble from electrolysis. In the case, however, of most cities where numerous lines converge at certain points, the double overhead construction would be complicated and objectionable in appearance. The same applies to the double overhead three-wire system. This last system has great advantages, however, and when used in connection with rotary converters, which act both as converters and equalisers, it is possible to operate tramways over very long distances from a single generating station.

The conduit system has been used in various American and Continental cities with a considerable degree of success. The advantage of this system is, that it can be a doubly insulated system avoiding danger from electrolysis, and that there are no overhead wires. An additional rail at the side or pair of rails between the tracks, along the slot, has to be set off against the overhead wires on making comparison between the two systems as to appearance in the street.

In general, corporations are in a better position to instal conduit systems than private companies, since corporations can borrow money at low rates of interest, and have not so great amortisation to consider. Further, corporations frequently having the control of gas and water pipes can arrange matters so that the conduits can be put in at a less first cost. In some cities I believe the installation of conduits under a dual management would be impracticable, since the conduits would interfere with the gas and water pipes to such an extent that the conduits could not be installed, except by such general re-arrangement, that local consent could not be obtained. Undoubtedly, in the case of heavy storms, the conduit system is more troublesome than the overhead system. I had some examples of this in my recent visit to the United States. In New York it has been found necessary to employ an elaborate system of double-throw switches, so that if a part of the positive side of the system goes to earth, it can be put on the negative side and the negative on the positive side.

The Dublin station has been designed to work all the cars in the City of Dublin and its suburbs. It is centrally located, and at the same time has exceptional facilities for coal and water supply. The coal is handled automatically from the ship to bunkers over the boilers, and from thence it is weighed separately into each boiler. The boilers are of the water-tube type, and the piping is on a system devised by myself, which I have termed the "bye-pass" system, since each pair of boilers normally supply its corresponding engine, but can, by means of the "bye-pass," supply any other engine. The engines are of the vertical cross compound type, 20 inches and 40 inches cylinders, 42 inches stroke and 90 revolutions.

In conclusion, I would point out that the mistake most frequently made has been in under estimating the amount of power that may ultimately be required in a traction system. Both the size and type of machinery in a generating station should be determined in respect to the maximum output of the station. Having regard to the present regulations of the Board of Trade and to economy in transmission and distribution, the limit for a 500-volt continuous current station is usually reached at 5,000-kw. output. Beyond this, a multiphase system of transmission with rotary transformers for continuous current distribution becomes necessary for most economical working, since experience has fully demonstrated the greater economy of working from a single central power station. The "universal" station is the multiphase station, since it can meet every condition with a single type of generating machinery. As pointed out in the paper, however, the distance of transmission, amount of power, and the nature of the load, are the factors determining whether a continuous current or a multiphase system is best in particular cases.

Having regard to lighting experience in the large American cities in which the three-wire system was originally installed, and which is now being replaced by a three-phase system with sub-stations to secure greater economy in working, it would seem wiser in many cases to sacrifice somewhat in electrical efficiency at the beginning and provide for a plant suitable for practically unlimited growth, either as to amount of power or area of district supplied from a central power station.

DISCUSSION.

Mr. Henry Edmunds, who presided, said the question before them that night was a very important one. He believed there were many gentlemen connected with the Manchester and Salford Corporations present who were largely interested in the question of electric traction, and one of the largest questions probably was, what system should be adopted, whether it should be overhead or underground. He did not want particularly to direct the discussion; he wished to begin with a very open mind. It would be very useful if the different gentlemen present would confine themselves as far as they could to the general questions raised in the paper, and, at the same time, he could quite see that Mr. Parshall had been very careful not to confine himself to any particular line. Speaking for himself, he had been closely in contact with the electric traction movement for a great many years. He thought in England they had the conduit system illustrated in a very primitive, and not unsuccessful way, in Blackpool some years ago by Mr. Holroyd Smith. Shortly after that they had the Bentley-Knight system and overhead, and the growth of that overhead system in connection with either single conductor or double conductor for the polyphase methods, as they had many examples of that in America and Europe to-day. He thought the æsthetic consideration was a very serious one. They did not want to disturb the streets. On the other hand, speaking not as an electrical engineer, but as one of the public, there was no doubt that it was a great nuisance to have any interference with vehicles which were not constructed to run on the tram rails. Two tram rails were bad, but two with a conduit were worse. Of course, the ideal mode was accumulators, but they were out of the question then. On the other hand, the overhead system had a great deal in its favour; it was extremely simple, it was comparatively inexpensive, and it did not commit them to a large expenditure of which they were not quite sure. They had all to go ahead. The public demanded electric traction, and they had to find out the simplest mode of supplying electric traction to Manchester. He thought eventually the simplest and cheapest would be the overhead system. On the other hand, let them take the æsthetic side. He had been in most of the cities in Europe. He would take a little place in Northern Italy, Lugano. There they had narrow streets and two overhead wires. They did not look so bad, and were well out of the way, and certainly they did not suffer locally any inconvenience from the overhead wires. In England they were altogether behind with regard to electric traction; all the small places on the Continent were connected one with the other with the overhead trolley system. The overhead system originally was probably a temporary one; people objected to it because they were not used to it, and it was an astonishing thing to note how a thing looked ugly when they were unaccustomed to it; later on it at least pleased the eye, and they were sorry to have it removed. He thought that the gentlemen who had to deal with the spending of the public money and the working of the systems must not consider simply the æsthetic point of view, but rather the commercial and practical point of view. He did not wish to put any bias to the discussion, but if they asked several of the gentlemen present to take part in the discussion, they would probably hear the *pros* and *cons* of both sides, and see which was the best thing to be adopted in Manchester.

Mr. Ferranti said he had listened with very great interest to the paper. The point with which he sympathised with Mr. Parshall was where Mr. Parshall told them that in cases of large stations they wanted to make the stations universal, a station which would not only feed the area round about it and the trams which ran near to it, but which would feed the tramways running into the country, and do the lighting load as well. He need hardly give any excuse for being thoroughly in accord with those views. They had been the views which he had held all along, they were the views which caused him more than 10 years ago to set to work the Deptford station. He would call their attention to the fact that although they started electric lighting many years ago with overhead wires, there were certainly good reasons for going underground. Anyone who had to do with that business in London, and knew what wayleaves were, and the trouble of getting them, and what they had to pay for them, would know that there was very good reasons for an underground system in that case. The telephone system was certainly one where the overhead wires were largely used, and were most desirable for getting conveniently to the different customers without spending too much money; still they saw those overhead wires coming down, and they were being replaced by well-protected cables laid in the street, which are in no danger in case of storms, and upon which the depreciation was very small. Now, was electric traction going to follow those other two systems of electric lighting and telephony, of which they had had some years' experience? What was really the best thing to put up in such a city as Manchester? It was very hard indeed to say. One thing he felt perfectly certain about was that if electric traction had been put in England about the same time as in America, then there would have been no question about what they should have put up. Certainly the overhead system would have been the right thing. He did not feel at all satisfied that this was the right thing to-day. Electric traction was wanted, and must be had, and it was absolutely necessary to decide what to do, and to do it. They were already seven or eight years behindhand, and they appeared to have got to such a state in the industry that some might say it was in a transient period. They knew that there had recently been installed some very large installations in the States on the underground system, and although it had not been a perfectly smooth and easy matter to work those systems, still they worked satisfactorily as regarded the public, commercially and practically. What they would be a year or two hence it was hard to say, but it was highly probable that the great desirability of that system being shown, and the demand for a system in the streets without overhead wires having been thoroughly demonstrated, the ingenuity of the country would be brought upon making that system perfect. Notwithstanding the great difficulties of having electricity in the mud, as it would be in this city of ours, it would be made to work, and would be a desirable, sightly, and perfect system for doing electric traction in the streets of the city.

Dr. Edward Hopkinson said he thought the chairman in his opening speech rather gave a turn to the discussion in directing it to the local question which was agitating them in Manchester at the present time. With regard to the system to be adopted when the Corporation changed the tramways of that locality to electric traction. The chairman had made a remark, which probably he had good grounds for making, and Mr. Ferranti had also repeated it, which struck him at the time as being rather off-hand. That was, that accumulators were out of the question. He would like to ask why? He had often asked that question, but he had never had an answer. He thought, at any rate, that accumulators were worth serious consideration, and he was not at all sure that they in England were not preparing for themselves a back seat upon the question of electric traction by refusing to consider the use of accumulators, when, if they looked abroad, many of the most important systems on the Continent had already adopted the accumulator system on a large scale, which in some cases had been satisfactorily at work for three or four years, and they were satisfied with the result both from an economical point of view, and from an engineering point of view. He believed in Hanover, which was one of the first towns to adopt the accumulator system, it had been at work now for two or three years with entirely satisfactory results. The same system had lately been adopted in Vienna, Dresden, and to some extent in Berlin. No one could doubt that outside the town in suburban districts, where there were no exceptional difficulties in the way of gas pipes, water pipes, &c., that either an overhead system or, in some exceptional cases, the conduit system, was much to be preferred on the question of economy, but when they came to the centre of the town the case was very different, and therefore those towns like Hanover, and the others he had mentioned, had adopted the overhead system of traction in the suburbs, and the accumulator system in the centre of the town. The accumulators were charged in some cases from the overhead trolley while running, and then run off from the overhead system fully charged, to do their service and return to their work on the outskirts. The disadvantages of the system were tolerably obvious. In cases like Hanover, where the cars were partially worked by accumulators, the dead weight of the car was increased some 25 per cent. by the weight of the accumulators. That, of course, meant 25 per cent. more power. There was also the question that the accumulators also required maintenance. That was a practical question which people knew very little about in England. They had had only one serious experiment with accumulator traction, and that was at Birmingham, on a line very ill equipped, and very difficult to work, and yet that line had been, and was at the present time, worked with entire success by accumulators, and he thought by the results which had been achieved, there was no doubt that more than one of the companies manufacturing accumulators in England at the present time would be willing to undertake entire maintenance of the batteries at a cost of 1d. per car mile, and would make a reasonable profit upon it. You have there a complete answer to the question of the cost of maintenance. He would go back for one moment to say that, in adding 25 per cent. to the weight, they must also add the loss of energy in the accumulator, which would probably add another 25 per cent., making a total of nearly 50 per cent. greater energy required per car mile with the accumulator than the overhead or conduit. The advantages, however, were obvious. Whatever the Corporation might, in their wisdom, decide to do at present in the way of adopting the conduit or overhead system, he was quite certain before very long they would see neither of those systems in existence. He would like to suggest to Mr. Alderman Higginbottom that it was worth while to make the same careful investigations into the question of accumulator traction, which he had done with such conspicuous success in the case of the overhead and conduit. He thought the discussion which had taken place in Manchester would show the firm grip they had got of the facts, and all he would ask was that the Committee, especially Mr. Alderman Higginbottom, should direct his attention to the question of accumulators. It would be no small advantage in a town like Manchester to get rid, absolutely, of return currents through the earth. No one knew better than Mr. Parshall what a difficult question that was. Mr. Parshall dealt with it in a number of cases with entire success, and there was no doubt that it could be dealt with in Manchester, but at a very considerable cost. He need not suggest the enormous advantage of getting rid altogether either of putting up poles for carrying the overhead wires, and in the case of the conduit system getting rid of the necessity of taking up the streets. It was sometimes said that the adoption of the overhead system would have a very great advantage over the conduit in avoiding taking up the streets. Feeders, however, would have to be laid in both cases, and with all due deference to Mr. Wordingham, the people of Manchester would be very glad if their streets were not so frequently disturbed. He would like, in conclusion, to refer to a remark of Mr. Ferranti's. He (Mr. Ferranti) was surprised Mr. Parshall did not give some definite opinion as to whether the conduit or overhead system was the most suitable. Mr. Parshall was a wise man, and would not venture an opinion until he was really acquainted with all the local conditions. He hoped Mr. Parshall at some future time after he had investigated the local conditions would give them the benefit of another paper, meanwhile the chairman of the Tramways Committee would do well to suspend his judgment upon the system to be finally adopted.

Mr. Clirehugh said there were one or two points which might be ventilated with advantage. One was with reference to the speed of the 1,500 kilowatt dynamos which Mr. Parshall designed, and in which he limited the speed to 75 revolutions per minute. He went on to say

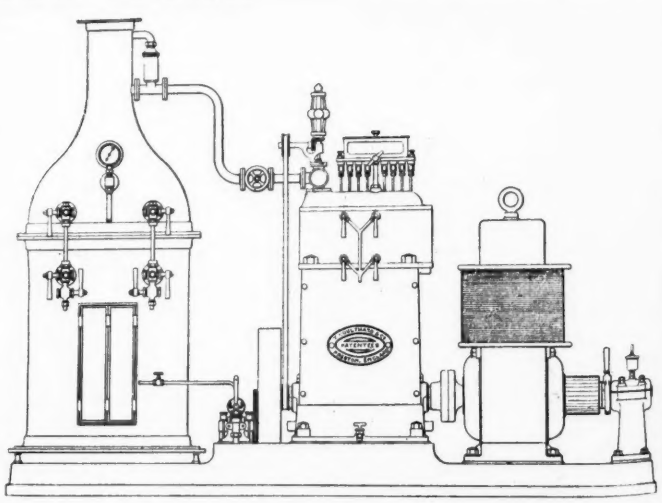
that "his own experience justified the statement that the mechanical and electrical conditions in the case of the larger direct connected generators, generally coincided in the matter of speed," which he, Mr. Clirehugh, took it to mean when boiled down that Corliss engines were not suitable to run higher than 75 revolutions per minute. Of course English experience differed very much from American. Another point he wished to mention. It was unfortunate that Mr. Parshall's drawings were not available. The author mentioned that he had designed a system which he called the bye-pass system, where each pair of boilers supplies its own engines normally, but by means of the bye-pass supply any other. That was not at all new in this country. With regard to the other matters, they of course invariably had to go back to the well-worn question of overhead *v.* conduit system, and the speakers up to the present had kept absolutely clear of mentioning either the advantages or disadvantages of either. He did not wish to lay down the law in any way, but it was obvious that it was primarily a question of capital expenditure as to which system they were going to adopt. With regard to the conduit system, they had an enormous mass of figures available, all of which varied immensely. They were told by some excellent authorities that the conduit system would cost £10,000 per mile, others came down to £4,000 per mile, all of which were probably perfectly accurate. The cost of the conduit system in England must be absolutely dependent upon the condition of the sub-soil. Those of them who had had experience of laying mains in English cities knew that the sub-soil was full of conduits and pipes, both alive and dead. If the conduit system to-day were introduced into Manchester, it was not inconceivable that it might, for a considerable portion of the distance, cost at the rate of £10,000 per mile. He would suggest that, although the traffic in Manchester perfectly warranted a very large expenditure, he was quite sure that they in Lancashire did not feel inclined to spend that heavy sum of money until they were satisfied that they had reached finality in the matter, and therefore he suggested that this discussion was somewhat unnecessary. They were bringing themselves to the verge of a panic on that question. They were not as ratepayers of Manchester in any way burning their boats if they did instal the overhead system. In a line which he had recently completed at Blackburn, the actual cost of the overhead equipment was £1,300 per mile. Everything used was absolutely common to either conduit or overhead systems, and nobody in the room would deny that whatever might be the merits of any existing conduit system, it was obvious that in 5 or 10 years they would have something better, and something which might differ very largely in principle. He knew it was a dangerous subject to mention amongst electrical engineers, but there was such a thing as the surface contact system. This system was got to such a state of prosperity, that one or two prospectuses had been published. There were elements of success in it, and he would be a bold man who would say that we should not have a good surface contact system in 10 years' time. If it could be made perfect, it was obviously better than any form of conduit system which existed at the present moment. The whole gist of his argument was this, they were discussing the question of sacrificing possibly £1,300 per mile for eventually getting something which might save them many thousands, because they were bound to put down a conduit which was not by a long way the best that they would be able to put down in 5 or 10 years' time. Mr. Ferranti mentioned that telephone wires and overhead electric lighting wires had come down; nobody knew better than Mr. Ferranti that those wires had their uses in their time. Therefore, he said, let the trolley wires be put up, and let them come down, but they must not take them down until they got something good. Dr. Ed. Hopkinson rather astonished him by getting up as an advocate of accumulators. Dr. Hopkinson said he had asked a large number of people the reasons that electrical engineers in general said that accumulator traction was to-day impossible; but he says that he never had a satisfactory answer. Dr. Hopkinson must be an extremely difficult man to convince. The answer to him seemed satisfactory. 50 passengers in a car weighed approximately 7,000 lbs.; the accumulators to propel these passengers would weigh 4,000 lbs. To travel at the rate of 8 miles an hour with this weight would take a large amount of additional horse-power. They all realised that if they could get lightness and economy in storage, it would be the ideal system. Manchester could not wait, and after all they were only sacrificing £1,300 per mile if they went on with something which they knew would work.

Alderman Higginbottom said as he had been brought into the discussion he felt bound to answer, not as an electrical engineer, but as a mechanical engineer, what he considered the right thing for Manchester. The whole thing hung virtually upon the local conditions of each town, and when they in Manchester considered the conduit or overhead systems, they must consider the local conditions as well. It was all very well to consider a town like Washington, with its different climate, and a town like Manchester, with its mud and wet. Again, they must consider the condition of the rails in Manchester, and the cost of installing in the first place. Taking Manchester, they had 67 miles of track, and with the exception of 10 miles, he believed he might say that the whole was fit to receive electric traction, whether on the overhead or conduit system. Now the cost of adopting the overhead system in Manchester would virtually be, from recognised authorities, £2,135 per mile of single track. Mr. Clirehugh put it down as low as £1,300. Of course, he was eliminating everything in that that was common to the system —tram rails pure and simple. Now, if they put down a conduit system for 67 miles of track, it would cost something like £700,000, as against £144,000 for the overhead system, and that was a consideration. But they had other things to consider. They had the question before them as to whether something better would not turn up in the future. He himself had always been a strong advocate with Dr. Edward Hopkinson, and he was looking forward to the time when the accumulator car would become perfect. If they put down a conduit system, they would have virtually lost their money. They would have to have eight rows of lines instead of four, and he was one of those who felt that every line they put in the street was very inconvenient in the way of horses. If they adopted the overhead system what could they do? Dr. Hopkinson himself admits that for outside the centre of the city, the overhead was the best system to adopt. If a better system were found for the centre of the city, the poles and all overhead apparatus could be fixed in the outside districts. Mr. Ferranti told them they were seven or eight years behindhand with electric traction; were they going to wait another three or four years? If they adopted the conduit system at once, they could not touch it until after 1901, when the lease of the Manchester Carriage Company expires. Now for the overhead system they could commence to bond their rails and lay their mains, and they could begin in 1901 without interfering with the traffic of the Carriage Company in any way. But suppose they had the conduit system they would have to wait until 1901. They would have to buy horses, cars, depots; in fact, take over the whole of the plant of the Carriage Company and work it by horse traction, converting the lines one by one to the conduit system. He would undertake to say that they could not do it under seven or eight years. What about Piccadilly, with all its crossings, with all its points. Why, in Washington alone a position similar to that cost £100,000 per mile of single track. Again, as one who had to look forward to making a profit for the ratepayers of the city of Manchester, they had to consider what was the most expedient to do under the present conditions. Equip overhead now, get possession of the lines, and leave the future to take care of itself; if something better came out they would then be in the best possible position to adopt it, and with the least possible expense. With regard to the accumulator system. He had directed his researches to that. He went to the Continent with the idea that the accumulator was the proper system. He visited Hanover, and the manager of the company told him that they were compelled to do without the overhead wire in the centre of the town, and therefore they had adopted the accumulator. If they could have had the overhead they would have put it in. An accumulator weighed 2½ tons, and the life of the cells was only two years, therefore the maintenance would be 50 per cent. upon every cell. The value of every car would be increased £250 by those cells, and they could not be commercially successful. Twenty-five per cent. for weight, and 25 per cent. loss in accumulators, total 50 per cent.; that would make the difference between working at a profit and working at a loss, and he thought until science had shown that a cell would work with far less loss than that, the accumulator car was out of the question.

(To be continued.)

HIGH-SPEED COMBINED LIGHTING PLANT.

We illustrate a new high-speed compound direct-driven electric light plant which is being manufactured by Messrs. T. Coulthard & Co., engineers, Preston. The boiler, engine and dynamo is supplied on one base plate, such an arrangement being well suited for "Colonial" or private installations. The illustration is taken from a plant capable of supplying current for 70 16-C.P. incandescence lights, or about 130 8-C.P. lights.



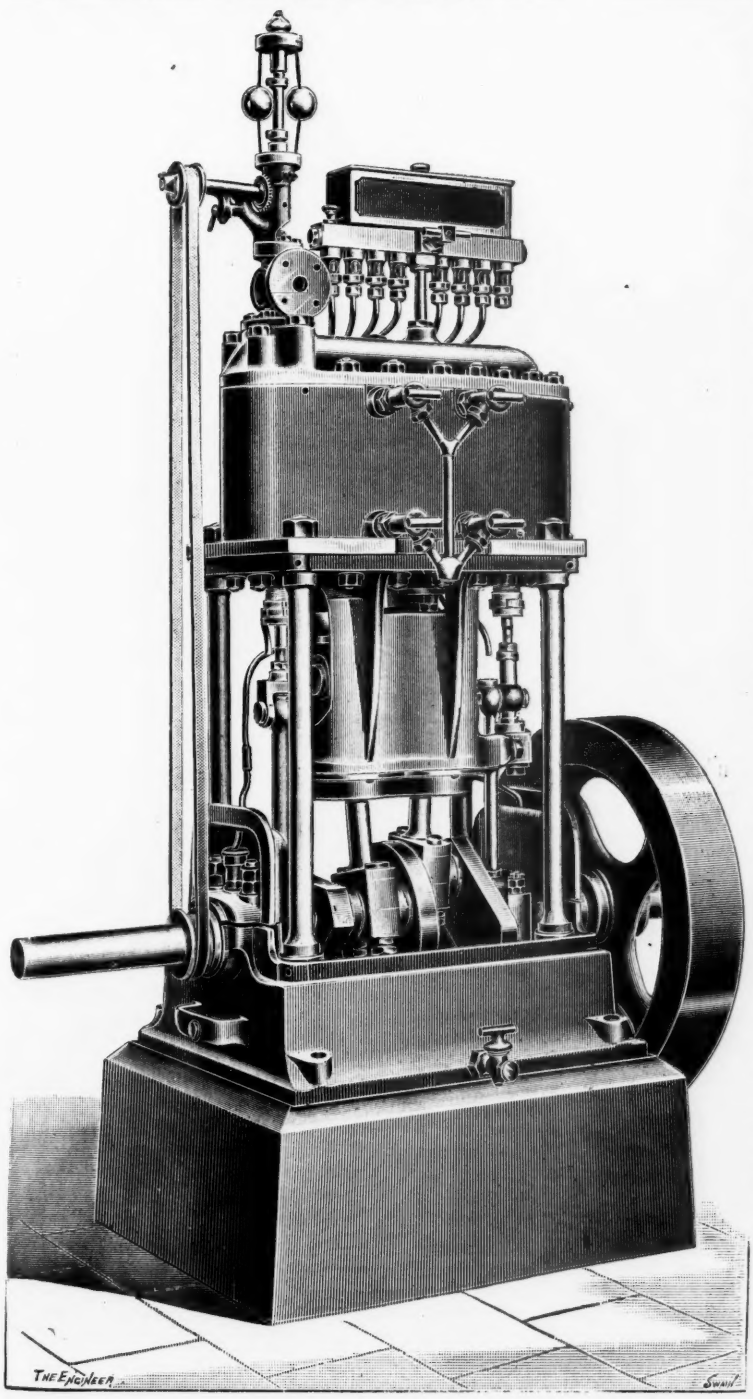
The consumption of oil fuel, such as common Russian or American oil, which can be purchased almost anywhere at 4½d. per gallon = 2 gallons per hour. Taking 70 gas burners at 5 cubic feet per hour, and gas costing 3s. 4d. per 1,000 cubic feet, which is about the price outside towns, this would represent a consumption of 350 cubic feet = 10d. per hour, against 9½d. for oil. Fuel, plus the water will not

exceed 10d. per hour. It is considered safe to reckon that in small plants the consumption of oil fuel and water would be about the same as ordinary gas lighting.

The dimensions of the combination are 7 feet long by 2 feet 9 inches wide, the weight under one ton. The dynamo shown is of Messrs. Ernest Scott & Mountain's "Tyne" pattern which is well suited for continuous running without over heating.

The engine is of Messrs. Coulthard's patent high-speed type, and is fitted with balanced piston valves to both high and low pressure cylinders, and the whole of the working parts are lubricated from one central oiler. Improved metallic stuffing boxes are fitted to the piston rods and valve spindles. For this engine are claimed all the advantages of the "open" and "closed" type of engine. It is enclosed in sheet steel covers, which can be removed in a few minutes.

The boiler is of the firm's latest pattern water-tube type. The distinguishing features are safety, straight tubes, rapid and uninterrupted circulation and large steam space. For cleaning purposes the casing can be removed in a few minutes. It will be seen that a door is fitted to the front of the boiler; this enables the burner to be started, and admits of inspection whilst working. A combined air and boiler feed pump is connected to the engine shaft. The air pump is used for supplying air to the oil tank which supplies the oil to the burner. A feed-water heater is also provided, which is coupled to the exhaust pipe of the engine. The feed-water heater is of large capacity, and it is thus possible to gain the advantage of supplying the feed water to the boiler hot, as well as to condense a very large quantity of the exhaust steam. These plants are made in sizes capable of supplying from 50 16-C.P. up to 250 16-C.P.



THE BALANCE OF TRADE BOGEY.

ACCORDING to Board of Trade returns, this country imports an enormous amount more than it exports. The correctness of the figures is doubted by the *Engineer*, and, probably, with justification. The balance of trade is like a red rag to a Spanish bull in its effect on "fair traders and protectionists, to give one set of people a double designation." They assume that Great Britain pays gold for the difference. Now, for years the so-called balance has been against us, and in that time Great Britain, a gold paying country but not a gold producing country, has paid away more gold than there is in the world. The question naturally arises whence came this gold, and why is there yet even so much left as a grain of the precious metal? For years the protectionist high tariff-mongers of America have used the argument *ad nauseam* to keep the American elector tied up in the thrall of protection, and Great Britain has, of all European countries, been the one particularly held up as sunk under an incubus of debt and poverty owing to free trade. The bogey of the trade balance has been ever held up to convince people that America was getting hold of all the British gold, and the day was joyfully foretold when, in the near future, America's best customer would sink beneath the waves, and leave the world to more enlightened high tariff nations. People of such narrow views entirely ignored the fact that America itself enjoyed free trade over an area of nearly four million square miles, and they could not see this was sufficient to account for America's abundant prosperity. It is well that the balance of trade bogey should be exposed or doubted. We have heard it stated that the apparent balance against us really shows that each unit of value we export brings us in something more than a unit, and this is profit; that we do not pay gold for the difference, but receive it as profit. It is certain we do not pay in gold. It is equally certain we do not increase our debts, and it is equally true that the country increases in its internal wealth and its outside investments.

Our contemporary equally sensibly points out that America cannot go on for ever exporting goods without taking goods in return, and that her entrance into outside markets is not to be feared, but rather made welcome as an indication that America must of necessity become an importer. It is a fact impossible to gainsay that no nation pays for imports except by exports—by the product of its labour, for no country produces much gold at a cheap rate. Gold costs its value to produce. In the early gold days of any country, as Australia or California, the gold is often cheaply procured from surface washings. But these are soon exhausted, and are only indications of gold bearing reefs.

The alluvial gold is available to give a start to a new country because it is so readily convertible into anything else. Reef gold getting then follows, and is simply an industry giving a narrow margin of profit, and demanding great expense in imported machinery and other necessaries. Gold-producing countries usually hold but little gold; it all goes in exchange for values received. The countries which possess the gold are invariably those in which the population work. That the United States export more than they import is no sign that the difference is paid in gold, but simply that they are either becoming creditors or are working at a loss, or are paying interest on external capital, which is helping to exploit and develop their large resources. The United States cannot pay interest except by their own products. The *Engineer* suggests that the United States may be selling on credit, and if so, must soon begin to import goods to defray these credits. The inevitable conclusion, as regards imports and exports, is that no nation can continue to make large imports for any length of time without becoming bankrupt unless such imports are paid for by exports. We are therefore paying for our huge imports by an apparently smaller value of exports. If this were not so the nation would be poorer day

by day, and could not be keeping up the continual investments abroad which are being made. As this same so-called adverse balance has been going on for years, is it not rather time that the alarmists began to seek some other cause for the adverseness in place of trying to cajole the country into a tariff war?

LONDON COUNTY COUNCIL.

The Council at the weekly meeting on Tuesday, resolved to lend £4,800 to the managers of the Central London Sick Asylum District for the provision of an electric light installation at a new asylum to be erected at Hendon.

The Telephone Service.

Colonel Ford, on the motion for the reception of the report of the Highways Committee, asked whether the Postmaster-General had replied to the Council in regard to the proposed municipal telephone service for London. Mr. J. W. Benn, in reply, stated that no further communication had been received from the Postmaster-General.

Electric Traction.

At the last meeting in December the Council instructed the Parliamentary Committee to seek powers in the next session to enable the Council to adopt electric traction on its tramways, and for that purpose to reconstruct the lines in such a manner as might be necessary. In this connection the Highways Committee stated that the Standing Orders of Parliament required the motive power proposed to be used to be specified, and in the case of mechanical traction, the mode in which such power is to be applied. Having fully considered the question, the Highways Committee recommended, and the Council decided to so amend the resolution passed in December as to allow of the use of the conduit, the trolley, or the surface contact system on the tramways. The Highways Committee reported that Section 22 of the North Metropolitan Tramways Act, 1897, empowers the company to use mechanical power on the tramways authorised by the Act, or any tramways for the time being leased to the company, subject, however, to regulations to be made by the Board of Trade for securing to the public all reasonable protection against danger, and for regulating the use of electric power; but Section 24 contains a proviso that the powers given to the company by that section, with regard to the use of electric traction, shall not be exercised in any place within the administrative County of London. The agreement for lease to the company of the Council's northern tramways, which agreement is confirmed by, and forms the first schedule to, the Act, contains provisions for experiments with electric traction on a part of such tramways to be selected by the Council, and the Highways Committee now expressed the opinion that the proviso above referred to appeared to be somewhat inconsistent with the provisions of the lease in this respect. The Committee pointed out that there appeared to be no doubt under the Act that mechanical traction other than electrical might be used on the lines leased to the company, and, in their opinion, it seemed desirable that the proviso in Section 24 should be annulled in order that the Council might, if so disposed, exercise the powers reserved to it in the lease as regards electric traction. The Committee accordingly recommended that the Parliamentary Committee should be instructed to take the necessary steps for the annulment of the proviso in the Act, and after a short discussion the proposal was agreed to.

On the recommendation of the Building Act Committee, the Council refused to consent to the erection by the Vestry of Battersea of a generating station in Lombard Road. The reason for the refusal was that the proposed wood and iron enclosure to the building was considered objectionable, and that in other respects the construction was unsatisfactory.

CORRESPONDENCE.

Cowper-Coles Electrolytic Cyclic Process.

I have read in the Electrical Review, for December 30th, 1898, Mr. Cowper-Coles's reply to the letter I addressed to that journal.

Allow me to call attention to the glaring errors contained in this reply, which would tend to imply that Hoepfner, Elmore, and others, made use before I did of discs constituting rotatory cathodes partly immersed in the electrolyte in order to collect by means of scrapers the spongy metal adhering to them when, in consequence of the rotation, part of the disc emerges from the electrolyte. The Elmore process, which is only applicable to the electro-deposition of copper enables us to obtain on cathodes of certain forms, tubes, or various shapes, by means of the copper which is deposited in the midst of the electrolyte on the cathodes.

In my process, on the contrary, the rotating disc which serves as a cathode is not entirely submerged in the bath, but only one segment of it, so that each portion of the dipping zone of the disc is alternately in the air and in the liquid which serves as electrolyte.

As to the Hoepfner patents, they cannot be quoted as prior inventions, since they were taken out after my patents.

Mr. Cowper-Coles maintains that, in his electrolytic processes, the cathode in the form of a rotating disc is not in any sense more than a secondary detail, and is therefore unimportant.

If Mr. Cowper-Coles will be good enough to suppress this *detail* (disc-cathode) in his electrolysers, and then try to extract the silver from argentiferous lead, for instance, he will be compelled to admit that without using my rotating cathodes it will no longer be possible for him to separate the smallest particle of silver from the argentiferous lead, or even to effect an easy and economical deposition of other metals. In fact, the chief characteristic of my invention, and the one which Mr. Cowper-Coles has taken care to imitate, is precisely the employment of rotating discs, and in all electrolytic operations these discs alone will enable us to realise certain advantages, which may be summed up as follows:—

1. The total suppression of polarisation (*a*) by the rotation of the disc constituting the cathode, (*b*) by the friction of the scrapers against the opposite faces of the discs, an operation which favours the giving off of hydrogen.

2. The metal precipitated on the disc is removed as it is deposited, from which result the following advantages: (*a*) The metal being continually subjected to the oxidising action of the liquid of the bath is not likely to be attacked, and consequently form local couples, the current of which is in an opposite direction to the principal current. (*b*) There is a considerable diminution in the electrical resistance of the bath since the anodes can be brought as close as possible to the cathodes without short circuits, which are always detrimental in any electrolytic decomposition. (*c*) A considerable saving of the electric currrent due to the diminution in the resistance of the bath in consequence of the possibility of bringing the electrodes together.

3. The density of the various strata of liquid traversed by the current is the same throughout owing to the rotation of the disc which agitates and stirs them continually, and consequently prevents the liquid from forming a sediment at the bottom, and thinning at the top as in ordinary electrolysers where the liquid is at rest.

From this explanation it follows therefore:—

1. That the electrolytic processes of Mr. Cowper-Coles are identical with those patented by myself long before.

2. That if we suppress the employment of rotating cathodes, the idea of which belongs to me, Mr. Cowper-Coles's electrolytic processes contain nothing really new or that can be considered as an invention.

D. Tommasi.

The Dow Compound Engine.

My attention has been called to a partial description and criticism of my vertical compound engine in your issue for December 30th, 1898. As you therein show that your understanding of it has been gathered from a greatly excised reprint of a paper read by me before the Engineer's Club of this city, I have mailed to you a copy of that paper, that the real work of the engine may be made clear, and I trust that you will permit me to justify my work in your columns. As you note, a "double vertical compound engine" with "cylinders closely side by side, no receiver, and with direct expansion," is often said to be on the "Woolf" system. This, however, is not necessarily correct, and it is not at all so as regards the engine in question. The "Woolf" engine of 1804 followed soon after that of Hornblower, and was a beam engine with both cylinders connected to one end of the "beam," consequently one of them was of shorter stroke than the other; the engine also possessing the very essential difference from mine of having the expansion conducted, through connecting pipes, from either end of the H.P. cylinder to the reverse end of the L.P. cylinder. This large intermediate space was fatal to the success of such attempt to use continuous expansion, particularly with the low pressures then in use. This engine was, at a later date, followed by the German "Woolf," which was a tandem engine, also with large connections from the front of one cylinder to the back of the other, and *vice versâ*.

As regards the "receiver." It seems to have arisen in consequence of the use of cranks set at the relation of 90°, which make it impossible to exhaust directly from the H.P. to the L.P. cylinder. You are right in supposing that I look upon it as a "heat radiator;" it certainly performs that office very efficiently as generally used, witness the ineffectual attempts to overcome this by re-heating within the "receiver."

But the principal criticism to which I desire to call attention is the statement that "the H.P. cylinder has in it the full range of temperature, from boiler to condenser, and one of the advantages of compound working is sacrificed, viz, the division of the range of temperature between two cylinders." I know that this method of expressing the advantage of compounding is often used, but would call attention to the fact that it only names a necessary incident and not the reason for the economy of compounding; which is plainly stated by the best authorities on thermo-dynamics of the present day as lying in the well ascertained fact that, because the greatest thermic loss to the cylinder is through "initial condensation," and because that loss is consummated by means of "re-evaporation" at the exhaust portion of the "cycle"; when the steam from the exhaust—with a sufficient remaining pressure—is received into another cylinder, having capacity sufficient to permit continuance of expansion, the loss of heat sustained by the H.P. cylinder is recovered in the L.P. cylinder, reducing the real loss of heat—not transformed into energy—for the combined cylinders to that sustained through the difference in temperature between the initial and terminal of the L.P. cylinder; and this loss is also consummated only by what is expelled through means of its own re-evaporation, *i.e.*, by its own exhaust. A careful examination of the cylinders and indicator cards of my engine will show that this loss from the H.P. cylinder is recovered much more effectively by the L.P. cylinder than when the large space for expansion and refrigeration is provided in a "receiver," and as the loss during exhaust of the L.P. cylinder is covered only by the difference of temperature due to the range in this cylinder, the loss by that means is no greater than when the expansion from the exhaust of the H.P. cylinder takes place against an artificial back pressure from a "receiver," which interposes an obstacle against the return stroke of the H.P. piston, which is removed by my system. This does not carry the *direct expansion* in that cylinder through the whole range, but at completion of *exhaust* the whole range *is* reached; against which the criticism will probably be made that thus the range of temperature is completed in one cylinder as though it were all direct. To this I answer, that as the loss to the H.P. cylinder is accomplished through re-evaporation, the more perfect that re-evaporation the greater the amount of heat units regained by the L.P. cylinder—not lost to the combination; and after this re-evaporation is complete there can be no further transference of heat. A careful examination of the indicator card of my engine (the double one shown with my paper is as carefully transcribed from actual records as was possible), will reveal the decided gain yielded from the exhaust of the H.P. cylinder to the expansion in the L.P. cylinder, the line representing both being necessarily coincident, and with a curve much above what an expansion unaided by that recovery of the H.P. cylinder's losses would have shown.

Josiah Dow.

Engineer's Club of Philadelphia,
Penn., U.S.

Teaching Electro-Chemistry.

An article appears on page 146 of this volume drawing attention to the non-existence of regular classes on electro-chemistry in the colleges of this country, and implying that the backward condition of electro-chemical industries here is to some extent due to this.

It is doubtful whether the article at all fairly represents the amount of instruction available and actually made use of in Great Britain. The subject is to some extent covered in an ordinary course of instruction in inorganic chemistry. Beyond this, it becomes a specialist's business, and can only be gone into by those who have already obtained a good knowledge of chemistry and physics. Such students do not need regular lectures, but can themselves carry out an experimental course of study in the laboratory, with little assistance, no very elaborate apparatus nor any great skill being necessary.

But a much more important matter is, whether there is or will be any demand for electro-chemists in England, or whether those who take up this subject are not even now in the same position as those who have studied organic chemistry. The article referred to mentions a class dropped for want of sufficient entries. Assuming that in this case there were no arbitrary restrictions on entries, such as employment in certain trades, it appears that students, even with the good advice which is no doubt available at the college in question, do not think this special knowledge worth obtaining. It appears of little use to the individual, and is only useful in a works with fairly large capital, which means that the average electro-chemist must work with or for those who can and will provide capital and business management.

Now, the manufacture of dyes, photographic developers, and many other chemicals, has been allowed to fall into the hands of the Germans, because our manufacturers, educated entirely in financial matters and in the control of rule-of-thumb processes, established in the absence of effective foreign competition, were unable to see the necessity for skilled technical assistance, or to appreciate its value. For a quarter century or more nearly every manufacturer said:—"There are no well-trained English chemists to be had. I have offered as much as £6 a month, and have never been able to get a really good one; and that with the prospect of rising to £7 or even £8, in a few years, if trade improves." The consequence is that chemists have found that they could do better in other businesses, where their special knowledge is probably useless, while chemical industries have not advanced as they might. German chemists were obtainable at the rate mentioned; after gathering up all the available technical information in a works, they returned to Fatherland, occasionally with data of prices and customers' names, and joined manufacturers with more brains, if less capital, than their English competitors.

What is wanted appears to be not more training for specialists in electro-chemistry, but better training for manufacturers than the financial and technical routine of old-established businesses, where sons learn only what their fathers knew, without any preparation for dealing with changing economic conditions.

T. H. M.

Electrical Fittings Censorship.

With reference to the question of efficiency in the use of high voltage or 200-volt fittings, may I ask you to insert this letter as a suggestion that the Municipal Electrical Association consider the expediency of formulating their requirements in some binding and definite manner.

Having moved amongst municipal electrical engineers for several years (10) over a wide area, it is found that the divergence of opinion as to what is suitable and what is not in fittings intended for use on the high voltage (200-volt) system is a cause of considerable embarrassment to manufacturers and to contractors.

The necessity for a rigid and qualified censorship over the adequate efficiency of switches, fuses, and other material used on 200-volt circuits is fully recognised and highly commendable; but the existing confusion arising in consequence of the inconsistent and contrary judgments of municipal electrical engineers over the whole country as to what is efficient, and what is not, is most mischievous to the public interest.

Manufacturers are harassed by the demand to cater for 100 districts, each local engineer insisting on his own ideas being carried out to such a degree that it often occurs that a fitting condemned in one town on a circuit of 200 volts is forced upon the contractors as the only suitable fitting in existence in another town and must be used. In one large city manufacturers are asked with an inconceivable amount of assurance to forward duplicate samples *carriage paid* (of fittings they propose to sell) to the electric light station for registration, the same duplicate samples to become the absolute property of the Corporation, otherwise no manufacturer must hope to do business in that city.

D

What will become of the manufacturers if this preposterous idea is imitated by all the numerous electrical departments of the towns and cities of Great Britain? Does it not mean that a considerable quantity of valuable material will accumulate in the various electrical departments idle and useless, useful only by the caprice and individual approval of multitudinous inspectors? And ultimately confiscated by the authorities?

The expense to manufacturers and contractors will be enormous, and the result profitable to the few, and disastrous to the many. This system of registration is already causing a great deal of unpleasant feeling, and hinders the contractor, who, however, has to sit and wait with patience, each contractor fearing to incur the displeasure of the electrical inspector by strong protest; he knows or fears what inconvenience he would be subject to in case the all-powerful inspector was obstructed, though often the most competent man is not the inspector. The following instance is one complaint:—A, being a manufacturer, sends a switch for registration, which is duly recorded and approved. A sells these switches to B, who in turn sells again to C, who, without further question fixes them on an installation. The inspector comes along when the work is finished, and asks where did he get these switches from and whose make are they? C states he bought them from B. Oh! says the inspector, B has not registered these switches, we know nothing of B, and they are condemned and must be taken down.

My object in asking you to insert this letter is to have a thorough ventilation of this grievance, and to persuade municipal engineers to be more liberal and unanimous in what is efficient for 200-volt material and what is not, so that by arriving at a consensus of opinion manufacturers would at once comply with requirements, whereas now they are simply groping in the dark.

The system of registration is a most unsatisfactory method of solving this problem. It is a system too costly, and it has the objection that where an inspector, whose duty it is to approve or condemn, is not fully competent or fails in strict integrity of purpose, the system becomes open to abuse, and we should frequently hear of fittings being approved of that ought never to have been.

C. A. Clarke.

Municipal Enterprise.

The article in your last issue headed "Municipal Enterprise" contains a moral for engineers.

Your views were the views of the Garston district until a consulting engineer appeared on the scene. He declared at once for a *central* situation for the proposed electricity works and refuse destructor. This placed the buildings right amongst the gardens and houses of the people who come from Liverpool—five miles away—to escape from works and tall chimneys and to enjoy rural surroundings. These people protested loudly that economy was no excuse for such an attack by a public body on their amenities, and the Local Government Board upheld their view. Exit the consulting engineer!

In the Liverpool autumn exhibition a remarkable painting represented "Blindness and Cupidity chasing Joy from the city." Perhaps engineers are not all on the side of Joy! Are they going to make Liverpool a place that no one will willingly live in?

J. R. P.

"Cyclist" and "Pertinax."

I have read Mr. Andreoli's letter, and now that he has the candour to publish his name instead of writing anonymously under such names as "Pertinax" and "Cyclist," I shall be very pleased to answer any questions he may have to put.

S. O. Cowper-Coles.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The meeting of the Institution on Thursday evening, January 26th, was devoted to a discussion on the papers by Mr. C. H. Wordingham on "The Regulation of Wiring Rules;" by Mr. R. E. B. Crompton on "The Institution Wiring Rules;" and Mr. J. Pigg on "Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains." The papers were taken as read, and a summary was given by Mr. Crompton and Mr. Wordingham. Prior to the ordinary business of the meeting, Dr. S. P. Thompson, who occupied the chair in the absence of the president, announced that the Council had—under the new articles of association which came into force at the beginning of the year—taken the opportunity to elect Lord Kelvin as an honorary member, the news being received with the utmost satisfaction by all present.

Mr. Crompton, in opening the discussion, appealed to those present to consider the desirability of adopting one uniform set of rules for the entire industry, with only such modifications as might be necessary to suit local conditions. The Institution Committee was very carefully chosen from men who knew all that was going on, and who were in close touch with electricity supply, while many engineers outside were consulted in the preparation of the regulations in draft. He did not say that the Institution rules were perfect, but he thought they were not very imperfect. Nor could he see that any of the large number of rules enforced at the present time contained examples so comprehensive or dealing with so many points. The point before the meeting was that the Institution rules might be amended or added to to get a set of rules which would comply with the standard of perfection desired by those who had to be responsible for work. He would then hope that fire insurance companies, municipal engineers, and others, would only have to refer to the Institution rules, and add to them to suit particular risks or local conditions.

Mr. Wordingham had not many words to say in addition to his paper, but he hoped that rules acceptable to all parties might be obtained. The subject of wiring rules was sometimes called hackneyed, so was getting bread and butter a hackneyed but very important matter. Wiring contractors had sometimes to work to three or four sets of rules, and some of these occasionally clashed. He had tried to show that there was a distinction between supply rules and wiring rules. Everyone must be prepared to give up something if we are to have uniformity.

Mr. Drake was naturally interested in the discussion, as he was associated with Mr. Crompton in assisting to draw up the Institution rules. He regretted the small extent to which the rules were taken as a standard, the reason, in his opinion, being the tacit opposition of the fire offices, each of which desired its own rules to be adopted. The insurance companies say, with some truth, that they have to pay the piper, and should therefore be allowed to call the tune. The only way of meeting this seemed to be concerted action on the part of contractors who had to do the work. If they could combine and work under the Institution rules only, the problem would be solved. A contractor, at present, must agree to carry out the rules of the fire office or offices interested, and if two insurance companies are involved, one may, for example, require a fuse in every ceiling rose, while the other objects to fuses in ceiling roses altogether. He believed the Whitworth standard screws were arrived at by striking a mean between the screws of all leading makers. Could not the same plan be adopted? If rules were not right let them be revised again, but at present the necessity exists for stocking patterns of all kinds of fittings, it being impossible to issue patterns that will comply with all the rules in force, and choosing the nearest to what is required or those acceptable to the office holding the major interest. He thought the suggestion of an Institution laboratory was an excellent one, but it should be restricted to a stating of the results of the tests made in the presence, if desired, of the manufacturer.

Mr. A. H. Howard mentioned that the formula for heating in the Institution rules was not arrived at by rule of thumb, but by preparing curves of temperature from experimental data. A German formula and table of current-carrying capacity corresponded very closely to that eventually arrived at. There were several reasons why it should be adopted in addition to that of general interest. The principal reason was that larger currents were allowed for small wires; this was of advantage to everyone except, perhaps, the cable manufacturer.

General Webber recommended Mr. Wordingham's excel-

lent little book of rules, *i.e.*, that in use at Manchester. The speaker agreed with Mr. Crompton and Mr. Drake that members have not given sufficient attention to the rules of the Institution. In 1883 rules were issued, 19 in number, requiring three pages. These are nearly as sound now as they were then. In 1888 a committee of revision produced 39 rules, covering six pages of the *Journal*. Both of the foregoing were strictly general, and avoided specifying how work should be done. Between 1883 and 1888 there was only one revision of the Institution rules, but there were some 9 or 10 revisions of the Phœnix Fire Office rules. In 1896 Mr. Crompton's committee was formed, and a third set of rules was issued in 1897. The title was altered, and a new departure in scope was made; the rules now numbered 15, and took up 14 pages of the *Journal*. The rules were brought up to date, and he believed were still up to date. Certain descriptions were added, such as the conductivity of copper. As regarded the suggestion of testing laboratories, the question was one mostly of funds. Kew, for example, was, to a certain extent, under the guidance and direction of the Royal Astronomical Society and the Royal Society; he thought such a laboratory might similarly be under the Institution of Electrical Engineers.

Mr. Bathurst protested against having any intention of riding his hobby-horse. It seemed to him that when wiring rules were discussed, uniformity is wanted, or rather no rules at all. In preparing the rules considerable difficulty must have been felt, there were so many different systems of wiring to be considered. In making rules to cover all systems, he thought we were going to handicap ourselves. Some years ago the speaker attempted to raise a scare in electrical fires, but was told by the insurance companies and others that we were not having fires. If this were the case, he thought the companies ought to assist the industry by reducing premiums. To force them to do this, if one could persuade contractors and their clients to give a particular set of offices all their business, pressure would be put on the tariff offices. Whatever immunity this country might possess, in the United States electrical fires had to be classed under 100 headings.

Mr. Bathurst proceeded at some length to detail his reasons for desiring earthing, and how the alleged troubles due to earthing could be got over. We are promised the conclusion of Mr. Bathurst's remarks in the *Journal*, his contribution being summarily extinguished by the chairman under the 10 minutes' rule.

Prof. Ayrton wanted to hear from the representatives of the fire insurance companies on what grounds they have decided to demand certain insulation resistances in wiring—some companies want 12 megohms per lamp, others 112 megohms per lamp. He asked whether 112 megohms is not a wholly unnecessary standard to aim at. Some idea might be given as to the principle on which these numbers of megohms have been arrived at.

Mr. C. A. Gawthorp thought all recognised the troubles of electrical contractors. He regarded the Institution rules as sound, practical, and scientific. He pointed out that supply companies and municipalities issued 10 times as many rules as were issued by insurance offices. Unless the former fell into line, it was hardly necessary for the latter so to do. He passed wiring which was carried out to the Institution rules.

Mr. H. Human spoke to the point, and his contribution was a valuable addition to the discussion. He drew attention to the many difficulties in the way of uniformity, amongst these being the vested interests of the individual, "letting alone his tender corns." After taking up in detail several of the rules, and comparing them with insurance ideas, he reminded his hearers that years ago he had suggested a simple formula— $\frac{\text{volts}}{\text{No. of lamps}} = \text{megohms}$, and he had also prepared a table of wiring which was based upon temperature.* He was pleased to see that the Institution has followed on similar lines.

One or two fire office surveyors having signified their satisfaction with the Institution rules, Mr. Wallis-Jones stated that this question should be looked at from position of outside public. Engineers were not agreed even among themselves as to a safe condition of working, and what constitutes a safe condition. There was one point in the testing of insulation resistance that was sometimes overlooked—the atmospheric conditions under which it was made. He thought that if wiring was cut down to 5-ampere subcircuits for 100 volts and 3 amperes for 200 volts, most risks would be avoided. He thought it questionable policy to earth the frames of motors owing to the risk of shock to the attendants.

Mr. Ruthven Murray and Mr. F. C. Raphael briefly touched on some of the points in the rules, the latter dealing with several discrepancies and referring to the conductivity of copper, which is stated without definition of the resistance unit in which the measurement is made.

Mr. Hirst regretted that nobody seemed to be acting on the rules. He enforced the risk of standards differing, and pleaded for some thought being given to the manufacturer. Mr. Galsworthy mentioned that insulation in new buildings was always low, while Mr. F. Brown amused the meeting by depicting the woes of the provincial contractor, whose time is taken up in scheduling for the benefit of the fire offices particulars of the work he has done. He thought that it was an omission in the rules that nothing was said about drop of E.M.F. At this point the discussion was adjourned until February 9th.

* This was referred to in the Electrical Review some 10 years ago.

THE LONDON TELEPHONE SERVICE.

On Wednesday afternoon a Conference of Delegates of the London County Council, the City Corporation, and other local authorities within the London telephone area, was held to consider the question of applying for a license to establish a telephone service within this area.

Alderman Sir Henry Knight welcomed the delegates, and said the matter they had to consider was of great importance in view of the scientific progress of the age. It was of the greatest importance, not only to the metropolis but to every municipality, and he hoped the result of their deliberations would be advantageous to the whole of the metropolis.

It was then moved and agreed that Mr. A. C. Morton (City Corporation) be asked to preside, and Mr. Morton proceeded to deal with the subject of the Conference. The whole of the local authorities had been invited to attend the Conference, and all with the exception of three had sent delegates. The whole metropolitan area covered by the National Telephone Company was 640 square miles. They were all aware of the absolute necessity of having an efficient telephone service at a reasonable price, and he believed they were all agreed that the service should be in the hands of the municipal authorities. There was one particular reason why municipal authorities should have control of the telephones, because they could not get a good telephone unless it was underground.

Mr. J. W. Benn, chairman of the Highways Committee of the London County Council, moved: "That this Conference of Delegates representing the London County Council, the Corporation of London, and the other local authorities within the London telephone area, is of opinion that a joint application should be made for a telephone license for the London telephone area in accordance with the resolution passed by the Court of Common Council on November 17th, 1898, viz., 'That application be made for a license to establish a telephone service in conjunction with the London County Council and other local authorities within the London telephone area.'" He said that the Post Office showed no desire to assist telephone users in that matter, and seemed rather to desire to maintain that partnership which had existed for years to the detriment of the telephone users of the kingdom. Much of the capital of the National Telephone Company was watered capital, and London was exploited to the tune of £76,000 a year to pay the interest on that capital. As to whether it was safe for the local authorities to take up the business, the London County Council had had estimates from Sir Alex. Binnie and after providing for all possible charges, and providing for sinking fund and allowing 10 per cent. royalty to the Post Office, he estimated that the annual cost of a telephone service for business purposes in London would be represented by the figure of £8 12s. per annum. They could conclude, therefore, that a £10 rate would afford sufficient margin for safety. It seemed that the Post Office was simply marking time to allow the National Telephone Company to get on its legs again. The Bills of the Telephone Company proposed to do away with the rights local authorities exercised over the streets, and they were to be handed over to the tender mercies of the Railway and Canal Commissioners, and unless that day they took up a firm attitude, the Telephone Company's interest was so strong in the House of Commons, that the Bills might receive favourable consideration.

Mr. Stocker (Willesden) seconded the motion, and contended that the local authorities should have competitive lines to reduce the compensation which would eventually have to be paid to the National Telephone Company.

Mr. MOOTJEN (City Corporation) trusted the Conference would be unanimous, so that they would be in a strong position when they applied for a license.

Mr. WILLIAMS (Hanwell) said he certainly thought that there should be a certain amount of credit given to the National Telephone Company for having done something for the public good. They must allow that people had sunk their capital in the company, and they ought to derive benefit from that capital. He doubted if the success of the Telephone Company had only been equal to the success achieved by the Works Department of the London County Council if Mr. Benn would have liked to have come in and experimented.

Mr. THORNTON (London County Council) supported the motion.

Mr. BEACHCROFT (London County Council) said that he had it in his mind that no license would be granted for a longer period than 1911. If so, it was a matter for serious consideration, and they had no figures as to cost before them. For 10,000 subscribers he took it the cost of establishing a service could not be less than half a million of money. If they were to be turned out in 1911, that was a serious matter. He believed in compromises, and it might be possible now to come to an agreement with the Telephone Company in the way of reducing the charges.

The CHAIRMAN said the resolution did not pledge them to take a license unless it suited them.

Mr. TRENCHARD (Enfield) said that they ought to know what scheme was intended if the license was granted. Were the outlying districts who had no telephone service now expected to surrender their own rights to the London County Council or the City Corporation. Would the outside districts be able to call on the central body to start a telephone service in Enfield at a reasonable cause ?

The CHAIRMAN said that as far as the Corporation had discussed the matter the understanding was that any scheme must have the support of the outlying districts, and all points would have to be settled before a Parliamentary Committee.

Mr. PARISH (Erith) asked how far they would pledge themselves financially if they supported the resolution.

The CHAIRMAN: That is answered by the last resolution.

Mr. PARISH asked also if they would be called together again to consider the terms for which the license might be granted.

The CHAIRMAN said that would be so.

The resolution was then put and carried unanimously.

There was a second resolution on the agenda paper to the effect that the proposed service should be managed by the County Council and the Corporation, but the CHAIRMAN said it was not proposed to move that resolution that day.

Mr. EMSLEY said that had the resolution been moved he should have moved as an amendment that the District Councils should have one-third representation in the management of the business.

Mr. BEACHCROFT said they could not ask for a license unless they knew who was to obtain the license.

The CHAIRMAN said the application would be made on behalf of the whole of the local authorities. In Parliament the question of who should manage it would be settled.

Mr. CORY-GRANT (Acton) thought the question should be settled at once, and he should move: "That this Conference is of opinion that the London telephone service should be managed by the London County Council, the Corporation of London, and the other local authorities within the London telephone area."

This was seconded by Mr COOPER (Edmonton) and supported by Messrs. Gridley (Hampton Wick) Baxter (Southall), Donald (Wimbledon), and Winser (Kingston-on-Thames), and agreed to.

Mr. SEEKS (Croydon) moved: "That this Conference recommend a joint application to the Postmaster-General for the telephone license in accordance with the foregoing regulations."

Mr. DOD (South Hornsey) seconded the motion, which was carried.

Mr. COOPER (Edmonton) moved that the town clerk of the City Corporation and the clerk of the London County Council be empowered to draft the application for the license and send it round to the local authorities for approval.

This was seconded by Mr. WILSON (Enfield) and carried.

Mr. BAKER (Beckenham) moved: "That these resolutions be submitted to the various authorities represented at this Conference for their confirmation."

Mr. WALKER (Kingston) seconded the motion.

Mr. CORY-GRANT moved as an amendment the addition of the following words: "With some details as to the expense of obtaining a license."

Mr. DOD (Hornsey) seconded the amendment.

The amendment was defeated and the resolution agreed to unanimously.

A vote of thanks to the chairman on the motion of Mr. BENN concluded the proceedings.

LEGAL.

THE VESTRY OF ST. MARY, BATTERSEA, *v.* THE COUNTY OF LONDON AND BRUSH ELECTRIC LIGHTING COMPANY, LIMITED.

IN the Court of Appeal on Monday, before the Master of the Rolls and Lord Justices Rigby and Vaughan Williams, the case of the Vestry of St. Mary, Battersea, *v.* the London and Brush Electric Lighting Company was heard on appeal by the defendants from an order of Sir Francis Jeune, sitting as an additional judge of the Chancery Division, who had granted an injunction and mandatory order directing the electric company to take up certain electric mains and wires which they had laid down in part of Trinity Road, Battersea.

Mr. CRIPPS, Q.C., who, with Mr. SHAW, appeared in support of the appeal, stated that the electric company had Parliamentary powers to supply electricity to Wandsworth, which adjoined Batterses. To reach a part of their district they had laid down mains in Trinity Road, Batterses, and it was in respect of the short length thus laid that the present action was brought. In the Court below two points were raised before the learned judge. One was whether the defendants were acting within their rights in laying down the mains in the Battersea district, but that was abandoned by the defendants. The real question turned upon the point whether, admitting that the defendants were acting outside their powers, the Vestry had sufficient interest in the sub-soil to entitle them to a mandatory injunction. The case for the appellants would be that the interest in the sub-soil belonged not to the Vestry but to the adjoining owner.

Mr. BRAY, Q.C., with Mr. CHUBB, who was for the respondents, argued that the very fact that the electric company were acting outside their authority was sufficient justification for a mandatory injunction. His contention was that the local authority had the control and management of the streets and to everything that was usually done with reference to the streets. It had been decided that the management and control of a street meant something more than the surface, but so much of the sub-soil as was usually dealt with in the construction of sewers, and so on.

Lord Justice WILLIAMS: You could have summoned these people.

Mr. BRAY: For doing it without notice?—Yes; but that does not take away our right. Counsel continuing, argued that the depth at which these mains were laid—some 2 feet below the surface—was within the area of the user of the street, and that the Vestry were entitled to their injunction.

Mr. CRIPPS having replied,

The MASTER OF THE ROLLS, in giving judgment, said that the case was not altogether a satisfactory one, and he might at once state that the Court did not consider they were in a position to grant a mandatory injunction upon the footing that notice to remove had been given under Section 109 of the Metropolis Local Management Act, and had not been complied with. Relief had not been sought on that footing. In 1896 the defendants, after failing to come to terms with the Battersea Vestry, and knowing perfectly well that the Vestry would object to their laying down their pipes under the streets under their control, took the law into their own hands, and, in an unlawful and high-handed manner, broke up the paving of Trinity Street for a distance of about 30 yards, and laid down their electric mains. This was in violation of all their Parliamentary powers, and was utterly and entirely illegal. The fact that the conduct of the defendants was utterly and entirely illegal was a great temptation for the Court to be high handed with the defendants, and say to them summarily that they must take up the pipes which they had wrongfully laid down. But they could not do that. They must not lose their heads, but must consider the rights of the parties, and when they were asked to grant a mandatory injunction, they must point out that the rights of the plaintiffs were not interfered with by the continuance of these electric mains and wires in the place they now were. Plaintiffs contended that these wires were only 2 feet below the surface of the ground, and that the surface of the street to that depth at least was vested in the plaintiffs. Of course, if that was so, the plaintiffs were right, and there would be a continued trespass of their rights of ownership; but the answer to that argument was to be found in a decided case in which the extent to which the soil of the street was vested in a local authority was very fully considered. In that case the local authority claimed to be the owners of the soil underneath the street, and the decision of the Court was against that contention. The extent to which the soil of a street was vested in a local authority was confined to so much of it as was necessary for the control, protection, and maintenance of the street as a highway for public use, and if that was so they could not maintain an action as owners of the soil under the pavement, and one of the most formidable grounds upon which the plaintiffs based their case was disposed of. Then the plaintiffs said that if they were not the owners of the soil they had over it a statutory control which was interfered with by the presence of the pipes. And he agreed with Mr. Cripps, that nothing had been done which interfered with their right of control. He felt bound to say he came to the conclusion he did with a great deal of regret, having regard to the manner in which the defendants had acted, but it did not seem to him that the rights or powers of the plaintiffs had been interfered with by the continuance of the pipes in their present position, and that part of the judgment which granted a mandatory injunction would therefore be reversed There would be no order as to the costs of the appeal.

GOLD *v.* WINTER.

THIS part heard action was down for hearing before his Honour Judge Lumley Smith, Q.C., in the Westminster County Court, on Monday, and was a claim for £75, balance of £100 commission in connection with the Chiswick provisional order for electric lighting. The case was fully reported in the REVIEW for December 23rd.

According to plaintiff's case, the Chiswick District Council obtained a provisional order in 1891, and Messrs. Bourne & Grant secured the option under that. Defendant agreed to pay plaintiff £100 commission on each provisional order he was instrumental in introducing to him, and of which he obtained the option. He was also to have a salary, and that he had been paid. He got the option of the Chiswick order, and defendant resold it to Mr. Brooke-Hitching for £1,000, and if a company was formed within six months he was to have another £1,000 in cash or shares. Plaintiff had only received £25 of his commission.

His HONOUR: Has Chiswick got the electric light yet?

Mr. Rose-Innes, plaintiff's counsel: They are playing with the option, sir. It has been resold for £5,000.

Mr. G. C. Marks, consulting engineer, called for the defence, said Mr. Grant died, and Mr. Bourne gave him instructions to sell the option. It was advertised and the purchase was carried out in 1897. The sale took place to defendant. The option would have expired two months from the date of the sale.

The case was now reported to have been settled out of Court.

Mr. Collins, clerk to the Chiswick Council, by his Honour's permission, denied the truth of some statements made at the hearing which he considered prejudicial to his Council.

Dia *v.* W. T. Glover & Co.

At the Manchester Assizes on Wednesday, before Mr. Justice Bigham, Mr. Heyl Dia, an electrical engineer, sought to recover damages for wrongful dismissal from Messrs. W. T. Glover and Co., Limited, electrical engineers, Salford. Mr. C. A. Russell, Q.C., and Mr. Sutton were for the plaintiff, and Mr. Pickford, Q.C., and Mr. Byrne for the defendant company. Mr. Russell said there was no dispute that plaintiff was in the employment of the company, under an agreement, as superintending engineer of what was known as the "diatrine" department of the company's business. Plaintiff was by birth a German, and he discovered an insulating material which could be used for electric cables in place of gutta-percha, and which would come in much cheaper, and that material he called "diatrine." There was no patent taken out, but it remained a secret process. He entered the service of W. T. Glover & Co. in August, 1894, at a fixed salary and a royalty on every kilo of the material which was used in applying to the cables. In 1895 the agreement was modified, whereby he entered into their employment for a term of five years at a salary of £500 a year and a royalty. Subsequently Messrs. Glover's firm was converted into a limited company, and in May of 1898 he entered into an agreement to continue the management of the diatrine department at £500 per annum for five years, and he also received, in the place of a royalty, a sum of £3,000, which was converted into 3,000 £1 shares in Glover's limited company. This agreement recited that all previous agreements should be cancelled, and that the plaintiff should serve the new company as superintending engineer and chemist for five years, commencing January, 1898. It also provided that he should communicate to the new company all the information he could regarding "diatrine," and to nobody else; and, further, that he should have the management of the "diatrine" department in the company's works. In connection with the payment of £3,000, the plaintiff handed over the cheque as soon as he got it in exchange for the transfer of the shares, and it was necessary here to point out that the defendants counter-claimed against the plaintiff for £15 5s. for stamps and transfer fees in connection with these shares.

The Judge: That is a very small matter. It is not worth mentioning.

Mr. Russell, continuing, said the position was something like this: that when he was asked by the late manager, Mr. Morton, who had since died, to pay the cost, the plaintiff refused, and said he was to have the 3,000 shares for the £3,000 cheque. Subsequently, Mr. Hartford was appointed secretary, but the plaintiff refused to receive instructions from him in regard to the technical management of his department, although the correspondence (which was read) showed he did not object to his carrying out the ordinary duties of his office. He was afterwards requested to give up his keys, and he wrote stating that he was not able to carry out the agreement under the conditions sought to be imposed, and that he should have to resign. Mr. Russell contended that this was not a resignation in a legal sense, and that as a result of the action of the defendants he had lost his interest in a valuable invention, as also a situation of £500 a year for five years, and, further, that since his discharge from the defendant company he had not been able to get another situation, in consequence of the circumstances under which he left.

Plaintiff was put into the box, and confirmed the opening of counsel.

In cross-examination by Mr. Pickford, he denied that he sent in his resignation except in a qualified manner. He was willing to go on under the old conditions. He admitted that he had received £100 in addition to the £3,000, but this, he contended, was due to him under the previous agreement.

In reply to the Judge, Mr. Pickford said the defence was that they did not dismiss the plaintiff, but that he resigned, and further, that even if he did not resign, they were justified in dismissing him for refusing to obey orders.

Mr. Henry Edmunds, one of the managing directors of the defendant company, stated that the company never intended that plaintiff should receive orders of a technical character from Mr. Hartford, but that they should only relate to the instructions previously conveyed as to the management of the business.

This was confirmed by another managing director, Mr. W. H. G. Fawcus.

Mr. Pickford contended, on this evidence, that plaintiff was responsible for the course he had taken, and must bear the consequences.

In summing up, his Lordship said the first question was, did the plaintiff resign voluntarily? If so, he was not entitled to compensation. The second question was, was he wrongfully dismissed? His Lordship went into the circumstances and said the correspondence showed that the defendant company was endeavouring to put him into a position for which he was not engaged. If they considered he had been wrongfully dismissed he was entitled to reasonable compensation.

The jury found for the plaintiff, damages £750. His Lordship said there was the other question of £100 paid to the plaintiff in March, 1898, and it was for the jury to say whether it constituted a part payment of the consideration money for the secret process, or whether the company had paid it to him in mistake. The jury also found for the plaintiff on this, and against the defendants on their counterclaim for £100 and £15 5s. His Lordship entered judgment accordingly and certified for a special jury.

BUSINESS NOTICES, &c.

Agency Notices.—Messrs. Foxcroft & Duncan, of Dalston, have appointed the Optimus Works Company, of Birmingham, sole agents for the Midlands for their arc lamps, measuring instruments, &c.; and Messrs. Morris, Warden & Co., of Glasgow, sole agents for Scotland and Ulster, for their measuring instruments; also Messrs. James, Mills & Co., of Salford, agents for their instruments for the North of England.

Announcements.—Mr. Alec. A. Beadle, A.M.I.E.E. F.C.S., announces that he has transferred his laboratories to 57, Chancery Lane, W.C., where he has conveniences for electrical, chemical, and metallurgical investigations and tests.

Messrs. Pauzetta Bros., cycle makers, 72, Charing Cross Road, W.C., have taken up the sale of electrical appliances.

Annual Dinner.—The employés of Messrs. Rosling and Appleby held their annual dinner on Friday, 27th ult., at the Talbot Hotel, Bradford, when about 150 sat down. Mr. Overend (works manager) was in the chair, assisted by Mr. Paus, assistant works manager. A musical entertainment followed.

Bankruptcy Proceedings.—The creditors of Edward Baldwin Pym, electrical engineer, Branham Gardens, South Kensington, and formerly of Scarborough, met on Monday, by adjournment, at the London Bankruptcy Court, before Mr. A. H. Wildy, Official Receiver. Accounts have now been filed showing liabilities £3,482 19s. 7d., and assets £112 10s. No offer was submitted, and the estate went into bankruptcy with the Official Receiver as trustee.

The Central News learns that an extradition order has been granted by the Italian Government in the case of Claude Vautin, the absconding metallurgist, of 88, Old Broad Street, and that the debtor will shortly arrive in London. It has further transpired that the £20,000 worth of securities alleged to have been taken away by the debtor have been returned through a bank, and are now in the hands of the trustee under the bankruptcy. The debtor's liabilities are roughly estimated at £69,000.

The first meeting of creditors in the case of Thomas Ford, chandelier and electrical fittings manufacturer (T. Ford & Co., Birmingham), will be held at Birmingham, on February 10th, and the public examination on February 24th.

Dissolution of Partnership.—Messrs. J. G. Dixon and H. F. Clayton (Dixon, Clayton & Co., electrical engineers, &c., Penistone and Huddersfield) have dissolved partnership. Mr. Clayton will attend to debts. The business will be carried on at the same address, under the management of Mr. J. Delebecque, and under the style of the Penistone Electrical Company.

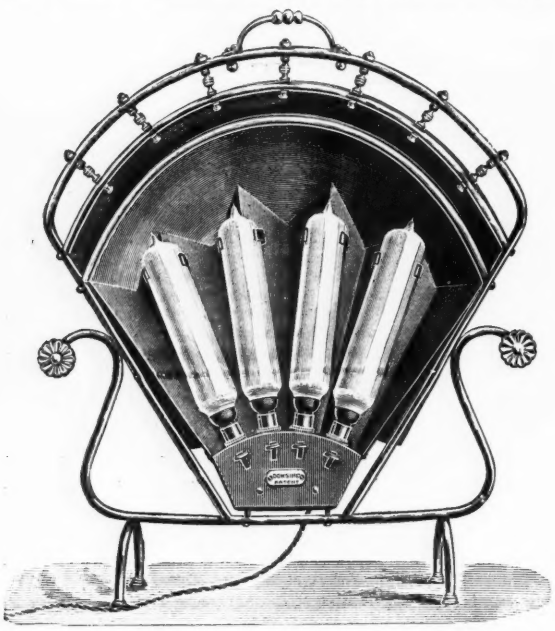
Liquidation Notices.—At meetings of Messrs. Mather and Platt, Limited, held on January 5th and 20th, it was resolved to reconstruct the company, and to wind up voluntarily for that purpose, Mr. John Mather, of 8, King Street, Manchester, being appointed liquidator. The liquidator was authorised to register a new company with the same name. An agreement between Messrs. Wm. Mather and John Robertson was approved.

The Medical Electro-Thermic Generator Company is to be wound up voluntarily, and Mr. H. E. Greville, 2, Staple Hill, W.C., has been appointed liquidator. A new company is to be registered with the same name, and a draft agreement has been approved.

The Hastings and St. Leonards-on-Sea Electric Light Company resolved at meetings held on 12th and 28th ult., to wind up voluntarily, Mr. J. Woodhams, Havelock Road, Hastings, being appointed liquidator.

Dowsing Luminous Electric Radiator. — Hitherto electric radiators have been of a non-luminous character, similar to hot water and steam radiators, and this fact has somewhat limited their use. The system of warming the air only of a room is not approved in this country, where the open fire is most appreciated. With the new luminous electric radiators, which we illustrate, intense heat is radiated (as from a gas or coal fire) into the room with the considerable advantage that no combustion takes place, that no fumes are created, no flue is required, and the heat is available immediately the current is turned on. These are advantages which are not found in any other form of heating apparatus. The luminous electric radiators waste no electricity, all is turned to heat, and the general effect is that of warm sunshine. The heaters are made on the principle of the electric incandescent lamps, and have carbon or high resistance metals enclosed in hermetically sealed glass protectors, from which the air is exhausted. The heaters, when used in conjunction with the patent reflectors, produce a considerable current of heated air besides radiating heat into the room. It is stated that they last a considerable time, usually much longer than incandescent lamps. They can be turned on and off at will, and no heat is lost in warming up or cooling down. Considerable saving in current is thus effected. These electric heaters can also be used for other domestic purposes where radiant heat is required, such as roasting (not baking),

grilling, toasting, warming food, airing, heating irons, and many other applications. The great advantage in all this is that the heat is immediately available, and as the intense heat rays pass direct to the object, there is little lost in heating the intervening air. Hence it is claimed that in all applications where radiant heat is required a far higher efficiency can be attained by these luminous heaters than with any other forms. Our illustration shows Type 3, which has an ornamental brass frame, patent copper reflectors, four luminous heaters, with switches. The current consumption is ¼ unit for each heater per



hour, hence one of these luminous radiators with four heaters will consume 1 unit of electricity per hour. We are also informed that Mr. Dowsing has the sole agency for England of the "Leroy" radiant heater, which was described in the Electrical Review last year. This consists of specially prepared high resistance blocks of Silicum about ½ inch wide × 3 or 4 inches long, enclosed in glass tubes from which the air has been exhausted. Each heater takes from 130 to 150 watts, and a number of these heaters are combined to produce sufficient heat for warming or cooking purposes.

The De Laval Steam Turbine.—With a nominal capital of £100,000, the De Laval new works at Leeds ought to be a success. The De Laval steam turbine may be described as the Pelton wheel of its variety, where the Parsons turbine is a guide blade wheel. It is said that the Swedish company have already made over 1,000 turbines, and the French company nearly 600. There is a field for steam turbines, and probably their economy will be improved for they start without that most serious of losses, initial cylinder condensation, which is so destructive of economy in the ordinary type of engine.

Electric Mining.—Messrs. John Davis & Son, of Derby, send us a copy of their 1899 catalogue of machinery, apparatus, and accessories required for the employment of electricity for lighting and transmission of power purposes in mines. There are illustrations and descriptions of electric pumping, haulage, safety motors, combined plants, the Jeffrey coal-cutter drill, shearer, damp proof fittings, electric blasting apparatus, &c.

Electric Clocks.—The Governors of the Enniscorthy District Asylum will consider tenders on Wednesday, February 8th, for an installation of electric tell tale clocks. Particulars on application to the resident medical superintendent.

Electrical Engineering on the North-East Coast.—In his address last week to the delegates at the annual conference of the Northern Union of Mechanics' Institutions, the president, Mr. W. S. Vaughan, M.I.C.E., discussed, under the title of "The Advance of Northern Industries," the recent progress and improvements in the three departments of shipbuilding, marine engineering, and electrical engineering as these are carried on along the North-East Coast between Blyth and Whitby.

Electrical Plant at the Barrow Steel Works.—The *Barrow Herald* says that the very complete electric lighting installation which the Barrow Hematite Steel Company have been putting down for the last six months is now complete. The engines driving this plant are to be worked by the waste gases from the blast furnaces, and so will not entail any cost in plant for boilers or fuel for the generating system. These engines have cylinders of 22 inches diameter and are the largest gas engines ever worked in Europe, and also the largest worked in this country from the gases from blast furnaces. The largest hitherto is one of 25 horse-power at the Frodingham Company's Ironworks, in Lincolnshire. The power of the pair which were tried some days ago is of 250 H.P., and is, we understand, only part of 1,000 H.P. installation. The engines have only just gone through their trials, and appear to work very satisfactorily.

Electrical Work in South America.—The New York *Herald* recently announced the incorporation of the South American General Electric Supply Company. This is said to denote the extension of the foreign policy of the General Electric Company, of Schenectady. Mr. Mazanet, late manager of the foreign department of the company, says that the organisation of the new concern means that the General Electric Company is to control more distinctively its foreign agencies, or rather it is to do away with foreign agencies altogether, and is to be represented in the foreign field direct. The object of the company is to sell electrical supplies to the Argentine Republic, Uruguay, Paraguay, Chili, and Bolivia, in connection with friendly companies already established in these countries. The capital of the new company ($50,000) is purely nominal. During the year just ended the General Electric Company's aggregate business with the Argentine Republic exceeded $600,000.

Electrolytic Prepayment Meter.—We understand that Mr. Bastian, the managing director of the Penny-in-the-Slot Meter Company, has perfected a prepayment attachment for the electrolytic meter made by the company, and that it will be shortly placed on the market. We are pleased to learn that many towns are adopting the ordinary electrolytic meter, among them being Bradford, Llandudno, and Windsor, and it is apparent that it is coming into general favour.

Factory Lighting.—Messrs. W. J. Furse & Co., of Nottingham, have been entrusted with the lighting of Messrs. Carey and Sons' lace factory at Southwell, near Nottingham, where they are installing about 300 lights.

Hart Accumulators.—Owing to considerable increase in business during the last three months the "Hart" Accumulator Company, of Stratford, have been obliged to extend their premises by taking over a large adjoining factory, covering 13,000 square feet.

Improved Electric Glow Lamps.—We are informed that at the late Turin Exhibition the jury awarded the Improved Electric Glow Lamp Company, Limited, a silver medal for the excellence of their lamps. The jury in their report, stated that the gold medal would have been awarded to the Glow Lamp Company, if they had not been of the opinion that the price of the lamp, owing to the heavy duty, was too high for the Italian market.

Intended Dividend.—February 13th is the last day for receiving proofs in the case of Frederick Jones (F. Jones & Co.), electrical engineer, St. John's Hill, New Wandsworth. Trustee: Mr. A. Mackintosh, official receiver, 24, Railway Approach, London Bridge, S.E.

Interior Conduit Wiring.—The Conduit and Insulation Company, Limited, sends us a pamphlet containing Mr. Bathurst's paper on "Electric Wiring Practice," read before the Association of Municipal and County Engineers last year, which is really an argument in favour of using the company's steel armoured insulating conduit. We understand that this material, notwithstanding its high price, is meeting with steadily increasing recognition by architects and engineers, and is being installed for much important work.

Lamp Envelope.—The Edison & Swan Company has issued a list of the "Ediswan" patent "Chameleon" lamp envelope, which consists of two parts, the upper of which is a reflector, or ornamental glass fitted upon the ordinary shade carrier of the lamp holder; the lower part consists of an ornamental or coloured glass which can be removed or exchanged as desired. The glasses can be supplied in any colour for producing different effects. The list is illustrated and contains prices.

The Large Power Schemes.—At Manchester Town Hall last week a meeting was held of the Executive Committee which was appointed at the recent conference of municipal corporations in Lancashire and Cheshire on the subject of the proposed Electric Power Bills. The chair was taken by the Lord Mayor (Mr. W. H. Vaudrey), and the Corporations of Liverpool, Manchester, Salford, Oldham, Blackburn, Bolton, St. Helens, Stockport, Bury, Wigan, Southport, and Chester were represented. It was resolved that communications should be made with all the municipal corporations in the area of the conference, urging them to adopt resolutions for opposing the second reading of the following Bills:—General Power Distributing Company, Lancashire Electric Power Company, South Lancashire and Cheshire Electricity Company, Leicestershire and Warwickshire Electric Supply Company, and the Midland Electric Power Distribution and Lighting Provisional Order. It was also decided to ask the Corporations concerned to affix their seals to a petition against the Lancashire Electric and South Lancashire and Cheshire Bills, and that the secretary of the Association of Municipal Corporations be authorised to act as the Parliamentary agent of the conference. It is stated that the promoters of the two Lancashire electricity schemes intend to ask the assent of the Standing Orders Committee to the suspension of the orders. Even if the Committee decides against them they can proceed with regard to the other districts which have not opposed at the preliminary stage.

The Parliamentary Committee of the Lancashire County Council, who have had under consideration the Bills of the Lancashire Electric Power Company and the South Lancashire and Cheshire Electricity Company, report that they "have no desire to interfere with the objects of the promoters of these Bills, being of opinion that in the interests of the country districts, every facility should be afforded to the inhabitants to obtain the benefits derived from the application of electricity for the purposes of power, lighting, &c., provided that similar protection is given to the ratepayers as appears in all Bills relating to tramways, waterworks, &c." The committee is in communication with the clerk of the Chester Council with a view to agreeing upon and

submitting to the promoters of each of the Bills clauses for the protection of the county interests, and pending the negotiations the Committee recommend that petitions should be presented against both Bills for the purpose of preserving the *locus standi* of the County Council.

The Leicester Town Council on Tuesday, and the Leicestershire County Council on Wednesday, unanimously decided to offer opposition to the schemes which are to be brought before Parliament this year for the supply of electric power over large areas by private companies. At the Council meeting, Ald. Lennard subsequently moved the adoption of the report of the Electric Lighting Committee, which stated that the total output of electric current from the central station for the half-year ending December 31st last was 302,531 Board of Trade units.

Lists.—Mr. W. Dittmar, of Plowden's Buildings, Temple, sends us a list of a patented recording ink pens which are claimed to be an essential adjunct to recording instruments.

Messrs. Nezot & Rafael Periago, of 3, Aldermanbury Buildings, E.C., who are the sole agents for the United Kingdom for Messrs. E. J. Damade & Cie., of Douai, send us a list of that firm's dynamo and motor brush specialities in copper, bronze, &c.

Private Bills.—Satisfactory proof of compliance with the rules of Parliament was duly given in the case of the Central Electric Supply Company (Powers and Works in Marylebone) Bill, and the St. James's and Pall Mall Electric Light Company Bill. In the case of the Kensington and Notting Hill Electric Lighting Bill opposition was offered by the parish of Hammersmith, which alleged that notice had not been given to them in regard to the intention of the promoters to construct a subway and to take up the roadway in a portion of the parish of Hammersmith outside the company's limit of supply. The Examiner declared the Standing Orders to be complied with.

The Examiners of private Bills have found the Central Electric Supply Company, (Powers and Works in Marylebone) Bill, also the Kensington and Notting Hill Electric Lighting Bill, to comply with the Standing Orders.

Smoke Nuisance.—At Southwark, before Mr. Slade, Mr. Edward Wilmot Seale, secretary of the Charing Cross and Strand Electric Supply Company, Limited, was summoned by the Lambeth Vestry for allowing black smoke to issue from their premises in Commercial Road. There were nine summonses in respect to offences on different days between the 3rd and 18th ult. Mr. Bodkin, who appeared for the Vestry, said that the company were fined £10 two months ago for a similar nuisance at their premises. The defendant said that the company had done everything possible. They were in a difficult position, because they were liable to a penalty of £50 a day under their provisional order if they stopped their supply of electricity. Mr. Bodkin said that this wealthy company were supplying the West-End with electric light and at the same time were poisoning the people of Lambeth with black smoke. Mr. W. H. Patchell, chief engineer to the company, said that he had made a special study of this smoke question, and had seen all the appliances for smoke consumption. He had made several experiments, had tried different kinds of coals, and the company were now erecting another chimney with more than usual rapidity. The new chimney will abate the nuisance. Until they got that chimney they were utterly powerless. Mr. Slade fined defendant £5 and 10s. costs on each summons—total, £49 10s.

At Greenwich on Monday, the London Electric Supply Corporation, Limited, Stowage, were summoned by the Greenwich Board of Works for not complying with a notice to prevent the recurrence of a nuisance caused by black smoke from a chimney at their works. For the defence it was argued that the corporation were using the very best quality coal and that their appliances were of the most recent pattern. The company's coal contractor said that no coal from the Rhondda Valley or Aberdare gave off black smoke. Mr. Kennedy fined the defendants £10 and £5 5s. costs.

Tramways Employés' Dinner.—The employés of the South Staffordshire Tramways Company were on Wednesday last week entertained to dinner in the Town Hall, Wednesbury, when the chairman of the directors, Mr. W. Somers L. Schuster, presided.

The "Universal" Engine.—The Brush Electrical Engineering Company, Limited, has issued a new illustrated pamphlet (30 odd pages) describing the "Universal" steam engine (Raworth's patent). The chief features of the engine are described, and notes are given on erecting and working. One part of the book gives notes as to standard sizes, spare parts and accessories. There are some excellent illustrations, and they are well printed on an enamelled paper.

1898.—Messrs. Drake & Gorham inform us that during the past year they have been exceedingly busy with installation work, having been entrusted with the lighting of a large number of country and town houses. Amongst the former may be mentioned:—Kedleston Hall for Lord Scarsdale; West Lodge, Darlington, for Sir David Dale, Bart.; Warnham Court for C. J. Lucas, Esq.; Chewardine Hall for Donaldon Hudson, Esq.; Basing Park, for W. Nicholson, Esq.; Lydham Manor for A. H. Sykes, Esq.; Fenay Hall for J. A. Brooke, Esq.; Fringford Manor for H. Chinnery, Esq. The London work includes the houses of Lord Encombe, Dowager Duchess of Marlborough, Lady D. Huddlestone, Sir William Young, Lord Yarborough, &c., &c. Amongst other installations may be mentioned that of Romford Brewery for Messrs. Ind, Coope & Company, where a complete system of lighting is now being installed, together with a number of electric motors for power purposes. The various branches of the firm at Manchester, Glasgow and Scarborough (now transferred to Hull) have been very successful and full of work. The large orders received for the D. & G. patent spring contact switches, and other goods specified in their catalogue, show that the excellence of their manufacture is much appreciated by the trade. The Jandus lamp still maintains its position in the enclosed arc industry which has been developed to a phenomenal extent during the past year. There are now many thousands of these lamps burning in all parts of this country, and, owing to the increased scale of manufacture, the prices have been materially reduced. The multiple series 2½ ampere lamps, and other new types for constant current working, have been developed during the year. To deal with electric traction on a sound basis a separate organisation, with a large capital—the Drake & Gorham Electric Power and (Pioneer) Traction Syndicate, Limited—was formed. It has a number of Bills before Parliament for consideration during the next session, and has already secured valuable concessions where orders are already acquired.

Water-Tube Boilers: Extension of Patent Refused. Last week Lord Hobhouse, Lord Macnaghten, Lord Davey, and Sir Richard Couch, heard a petition for the prolongation of letters patent granted to Mr. John Isaac Thornycroft, of Church Wharf, Chiswick, on January 31st, 1885, for a term of 14 years for an invention of improvements in steam generators. Mr. Moulton, Q.C., and Mr. J. C. Graham were counsel for the petitioners; the Attorney-General and Mr. Denniss for the Crown. The invention in question related to improvements in water-tube boilers, and it was claimed that, through the more perfect circulation obtained by it, a higher efficiency of heating surface was secured with corresponding economy of coal, and by that and by the arrangement of the outer tubes so as to form water walls, which necessarily limited the temperature of the radiating surface to that of the water, the use of heavy, refractory, non-conducting materials was avoided, and a great saving in the weight of the boilers was obtained. The invention, it was said, was of great utility and particularly applicable to marine machinery, in which it was important that the greatest possible horse-power should be obtained with the smallest weight of boilers and fuel to be carried in the vessel. In consequence of the doubts which were generally felt by naval architects and engineers of new forms of boilers, and their fears of the grave consequences which might follow from any failure of such boilers, the invention had not, says the *Times* report, until recently, come into any extensive commercial use, and the petitioners had not derived adequate benefit from it. They believed they had now succeeded in attracting the attention of shipbuilders and engineers to the value of the invention, and if the term of the letters patent should be prolonged they hoped to be able to obtain a fair remuneration commensurate with its merits and public importance. Evidence was given in support of the petition and as to the merit and value of the invention. The accounts were also submitted to their Lordships. At the conclusion of the hearing, Lord Hobhouse said their Lordships would humbly advise Her Majesty to refuse the prayer of the petition, and they would give their reasons at a later date.

ELECTRIC LIGHTING NOTES.

Barking.—The consulting engineer and surveyor are to report upon the required extensions to the mains and electric light stations.

Bath.—After many discussions as to the respective positions of Mr. Metzger and Mr. Robert Hammond, and on the question of whether the services of the latter were now necessary, the City Council has adopted a recommendation from the Electric Lighting Committee:—"That, having regard to the advanced progress of the work now being carried out at the electrical works, under the supervision of Mr. Hammond, and the desirability of placing the works under the charge of the city electrical engineer, this Committee desires the Works Committee to confer with Mr. Hammond to secure a transfer of his duties to Mr. Metzger." A letter has since been received from Mr. Hammond, and this has been referred to the Works Committee.

Batterseas.—The Special Committee on Parliamentary Schemes reported to the Vestry last week having had under consideration the Bill to be introduced by the County of London and Brush Provincial Electric Lighting Company to connect their areas of supply and break up the intervening streets. The Vestry approved the action of the Committee in approaching the other local authorities affected by the Bill with a view to their co-operating in opposing the measure, and in inquiring whether the London County Council should be invited to render assistance in opposition to the Bill.

Beckenham.—The electrical engineers (Messrs. R. P. Wilson and W. H. Story) recently reported to the Electric Lighting Committee upon the tenders received for electric lighting plant, &c. The lowest tenders conforming to the specification were:—Messrs. Babcock & Wilcox, Sec. A, boilers, £1,450; Messrs. Fowler & Co., Sec. B, alternators, transformers, and switchboard, £5,934; Messrs. Babcock & Wilcox, Sec. C, steam, &c., pipes, £1,584; decision has been deferred as to estimate for purposes of loan, say, £1,500, Sec. D, arc lighting, £1,500; British Insulated Wire Company, Sec. E, triple concentric cables, £13,116; particulars awaited, Sec. F, travelling crane, £150; total for machinery, cables, &c., £23,734. The total amount will then be as follows:—Tenders for generating machinery and cables, &c, £23,734; engine house (estimated cost) £4,000; dust destructor, £1,500; approach road thereto and retaining walls, £750; pump well, £750; add for contingencies, legal, and engineering expenses, &c., say, £5,266; total, £36,000. The Electric Lighting

Committee has ordered that the matter stand over until certain alternative tenders were received, such tenders to be considered in private.

Belfast.—Some consumers having complained about the present system of charging for current being unfair and unequitable, a sub-committee of the Electric Committee is going into the suggestion to introduce a uniform charge.

Birkenhead.—Tuesday's *London Gazette* contains notice by the Corporation to the effect that they intend applying to the Board of Trade for a license to supply electricity within the townships of Bidston-cum-Ford and Noctorum, in the county of Chester.

Brighton.—The Lighting Committee of the Town Council have accepted the tender of Messrs. Willans & Robinson, Limited, to supply and erect two combined engines and dynamos, with condensing plant, at a cost of £15,191. The committee have also decided to appoint an assistant manager of the Corporation electricity undertaking.

Bristol.—It is stated that the demands for current have been so heavy, all the money voted for main extensions has been spent, and the Electric Lighting Committee is coming to the Council for their sanction to a small loan for further extensions, without waiting for the much larger loan which may be required before the year is out for extending the plant and buildings at Temple Back.

Buxton.—The Council has given the contract to Mr. Vickers, of Nottingham, to erect an electric lighting station for £3,800.

Camberwell.—The Vestry will oppose the Bill of the County of London and Brush Provincial Electric Lighting Company, and is asking the London County Council to convene a conference of all the authorities interested under the Bill, in order that joint action might be taken for the purpose of protecting their interests.

Cape Town.—A large extension of the electric lighting plant at Cape Town is in contemplation. Mr. T. Stewart, C.E., has submitted to the General Purposes Committee of the Town Council a report on the utilisation of hydraulic power from the reservoir on Table Mountain which supplies the town with water. Though sufficient to generate all the electric energy required for many years to come, this scheme is estimated to cost about £70,000. When the last mail left the Council had under consideration a more modest scheme, to cost £20,000, and which, if approved, is to be carried out at once.

Chelmsford.—Mr. Reeves, secretary of the Chelmsford Electric Lighting Company, appeared before the Town Council on Wednesday last week, and explained the causes of several recent failures in the lighting. He defended the company against recent complaints which had been made, and afterwards informed the Council that he wished to lay another matter before them. For years the electric lighting at Chelmsford did not pay; but now it was paying, and last year made a profit of about £1,000. Messrs. Crompton & Co. had money locked up in the Lighting Company, and they wanted to put that money in their other concerns, where they could use it much more profitably, and he had decided with the sanction of his directors, to invite other people to take the lighting concern off their hands. In fact, he had made arrangements, which were almost concluded, for placing the Lighting Company in other hands, but he would ask the Council whether it was not in their interests, as representing Chelmsford, to secure the lighting of the town for themselves. The lighting was now paying; they had 750 applications for 8-candle power lamps; they were going to erect a new building, and were going to extend their mains into Springfield. The capital in the Lighting Company was about £41,000 to £42,000, and the Town Council could now purchase the interests of the company at cost price. If the Council, however, did not seize this opportunity the concern would pass into other hands, a large company being formed to take a considerable number of undertakings in this country, and the Council would not be able to purchase the undertaking until 21 years had passed, and then they would have to purchase at a valuation. If the Council entertained the offer he would be pleased to confer with a committee. The meeting asked Mr. Reeves to reduce his statement to writing.

Chester.—The Town Council has authorised the Lighting Committee to have the necessary arc mains and distributing mains laid for supply of public and private lighting to Tarvin Bridge, the estimated cost, including four arc lamps, &c., being £1,385.

Coventry.—The City Council will petition against the Leicestershire and Warwickshire Electric Supply Bill.

Darfield.—Several large ratepayers have lodged objection to the proposed electric lighting scheme. They say that public electric lighting is not necessary for so small a place as Darfield. The Council has appointed a committee to prepare evidence to combat the statements made by the objectors.

Dover.—The question of purchasing the gas and electricity undertakings was again before the Town Council last week, and after a discussion it was decided that the Managing Committee should go fully into the matter.

Exeter.—With reference to the recent memorial to the Council complaining of smoke nuisance and vibration in the neighbourhood of the electricity works, the electrical engineer has now reported to the Council that there has been no ground for complaint as to smoke nuisance since the Welsh coal strike ended and supplies of steam coal have been obtainable. The vibration is declared to be a delusion. All that was the matter was a noisy exhaust which had been in use temporarily while some alterations were being carried out. The exhaust is no longer in use, and with the cessation of its noise the other troubles have doubtless vanished.

Gillingham.—At the meeting of the Urban District Council, held at New Brompton, Chatham, on the 26th ult., there was a long and somewhat heated discussion in reference to the electric light, by which the town is at present lighted. The Survey Committee had recommended that the terms of the Local Electric Lighting Company as to lighting the High Street be accepted. A motion to this effect was carried.

Gloucester.—Mr. Robert Hammond delivered an address on "The Gloucester Electric Lighting Scheme," under the auspices of the Gloucester Engineering Society, on 24th ult.

Glasgow.—33 offers were submitted for the supply of the new machinery required at the Pollokshaws Road and Port Dundas electric lighting stations. The engineer will prepare a tabulated report.

Grays.—In connection with his recent report on electric lighting, Mr. Preece is now to report on dust destruction.

Hanwell.—The Middlesex County Council is approaching the Ealing Council to ascertain at what cost it would supply current for Hanwell.

Hove.—A gas leakage caused an explosion in an electric light culvert at Church Road, Hove, on 28th ult.

Hoylake and West Kirby.—The law clerk is to prepare an agreement with Mr. Miller as to his appointment as consulting electrical engineer, and submit it to the next District Council meeting.

Hull.—Last week the electrical engineer submitted estimates of the probable income and expenditure for the current year, showing an output of 800,000 units, which at an average of 4½d. per unit would produce an income of £15,000. After providing for expenditure, there was an estimated profit of £1,545. This is somewhat less than the balance for 1898. The estimates will be considered at the next meeting of the Electric Lighting Committee.

Lee.—The District Board of Works on Wednesday resolved that Mr. Albion Snell, electrical engineer, be temporally appointed at three guineas a day to answer certain questions put to the Board by the Board of Trade in reference to the electric lighting by the Blackheath and Greenwich Company. It was also resolved to advertise for a consulting engineer at a salary of £100 per annum to advise the Board as to the laying of the mains and works.

Leicester.—The Parliamentary Committee of the Leicester Corporation on Saturday published an emphatic protest against the proposal of the Warwickshire, Derbyshire, and Leicestershire Electric Supply Company to obtain a Bill to enter Leicester and other boroughs in order to compete with the municipal authorities in the supply of electric energy. The committee recommend that the company's Bill should be vigorously opposed.

Liverpool.—The Parks and Gardens Committee protests against the appropriation of land adjoining Lister Drive, Newsham Park, as a site for an electric generating station, on the ground that it is required for recreation purposes.

London.—At the meeting of the St. Giles Board of Works last week it was stated that at the last meeting of the Board, through the Charing Cross and Strand Electric Supply Corporation keeping open for a long time large sections of the roadways when laying their mains, the clerk was directed to inform the corporation that in future the Board will open the trenches necessary for the laying of the mains, and restore and make good the paving afterwards, and if they thought it desirable they would submit the question to the decision of the Board of Trade. Their objection was that the corporation would not put themselves under the obligation of not opening more than 50 feet of the roadway at one time. He had a letter from the corporation stating that they would only open 15 feet of the roadway at one time and would fill in the trenches at night. This offer he had accepted. The action was approved.

A committee of the St. Olave's Guardians are considering whether to light the new workhouse by electricity from private plant or to take a supply from a company.

Lowestoft.—Last week a Local Government Board inquiry was held into the application of the Town Council for sanction to borrow £4,709 for a refuse destructor, to be erected on the north-west corner of Smith's Marsh.—Mr. C. H. Wiltshire objected to the erection of the destructor at Smith's Marsh on behalf of several property owners.—The town clerk explained that the site selected could with advantage be used for the joint purpose of a destructor and electric supply works. The engineer was satisfied there would be no nuisance. With reference to carrying the refuse through the streets, it was proposed to have an electric railway, and the Corporation would construct a siding.—Mr. W. C. Hawtayne, electrical engineer, expressed his opinion that the site was the best to be procured.

Manchester.—At the next meeting of the City Council, the following advances of salary in connection with the electrical department will come up for confirmation:—Mr. Fredk. Hughes, secretary, from £250 to £350 per annum; Mr. A. A. Day, chief assistant engineer, from £275 to £325; Mr. P. J. Watts, assistant engineer, from £163 16s., to £185; Mr. W. F. Long, assistant engineer, £163 16s. to £185; Mr. I. A. Cookson, draughtsman, from £163 16s. to £180, and Mr. W. McClelland, chief clerk (works), from £150 to £180.

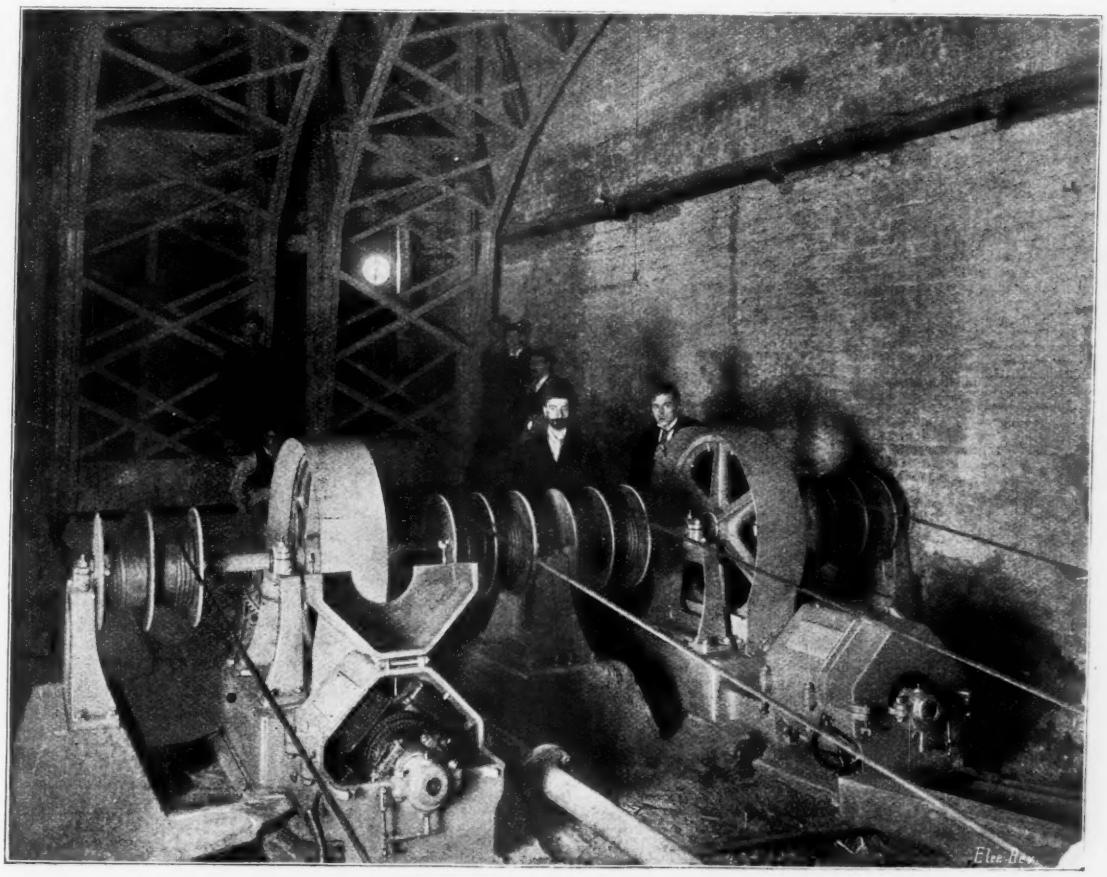
(*Continued on page* 173.)

ELECTRIC ELEVATORS AT DRURY LANE THEATRE.

Judged by Continental standards we are, in the applications of electricity to stage mechanism, very much behind the times, but the recent work designed, constructed, and erected at Drury Lane Theatre by the Thames Ironworks Company, to the instructions, and under the supervision, of Mr. O. Sachs, will probably do much to bring before theatrical managers the merits of electricity. In remodelling the Drury Lane stage, the idea is to make the floor in movable sections or platforms. Two sections have been completed and consist of platforms carried on bridges each being approximately 40 feet long by 8 feet wide. The bridges consist of two light steel arched lattice girders of simple but substantial design; they are 38 feet 10 inches in length, spaced 5 feet 6 inches apart in one elevator, and 5 feet 2 inches in the other, and well braced together to form one rigid structure, on the top of which the flooring forming part of the stage is fixed. The steel portion of each lift weighs a little over $4\frac{3}{4}$ tons; the wooden platform which forms part of the stage floor, together with the joists on which it rests, weighs about $1\frac{1}{2}$ tons more, the total weight lying between 6 and $6\frac{1}{2}$ tons. From 4 to $4\frac{1}{2}$ tons of this total weight is counterbalanced.

The elevators have been designed to travel from the mezzanine floor, situated 8 feet 6 inches below the stage, to a height of 10 feet 6 inches above the stage, and to ensure smoothness and silence in working, with freedom from "binding," the ends or legs of the girders have been made of a considerable depth, sliding in angle guides attached to substantial steel stanchions.

The mechanism which elevates the lifts is placed entirely below them, in order to allow a clear uninterrupted floor when the top of the lifts are "flush" at ordinary stage level. Each lift has a totally independent and complete set of mechanism to work it. Power is supplied from the electric mains to a four-pole enclosed type shunt wound motor, which develops $7\frac{1}{2}$ horse-power at 520 revolutions per minute, but is capable of working at higher rates on emergencies. The speed is reduced in the ratio of 104 to 1, through a large worm and worm-wheel, as shown in the illustration, the worm-wheel being geared to a shaft which carries two winding drums, making five revolutions per minute. Upon these drums are wound steel wire ropes, which pass over guide pulleys and are connected to four places on the legs of the lift—one near each corner. The speed of lifting corresponding to the full speed of the motor is 16 feet per minute, which can be reduced through resistances in circuit with the motor to 6 feet per minute.

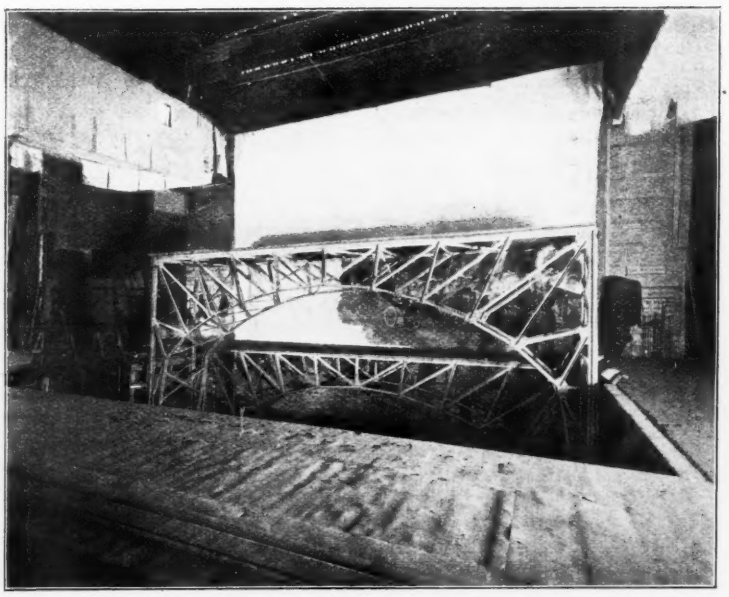


General Arrangement of Motors.

There are compensating arrangements for equalising the tension in the ropes, so that the pull is quite steady and uniform. The movement of the lift is controlled by a combined starting and reversing switch, which is operated by a man at a station below stage level, so placed that he can see the elevators. A hand gear is provided for working each lift in case of failure of the electric power. On the opposite end of the worm-shaft to the motor is keyed a spur-wheel, a similar wheel keyed upon a double handle like an ordinary crab being arranged to slide into or out of gear with it. The operation of changing from "power" to

"hand" working, or *vice versâ*, takes but a few seconds. As is usual in lifts which have to carry people, safety catches have been fitted for holding the lifts stationary in the event of a rope breaking, and automatic switches have been provided for cutting off the current from the motor in case the attendant should forget to switch off at the right place. Gear is also arranged to lock the "bridges" in certain positions when used as part of a fixed scene. A large factor of safety has been allowed in apportioning the strength of the various parts of the mechanism.

The lifts have been thoroughly tested and have worked with great smoothness, and without any jar or shock on starting or stopping. They were designed to carry a live load of 2 tons, representing the weight of about 30 people, but they have during the tests operated much heavier loads than this. One of the views reproduced shows each lift loaded with a coach weighing 32 cwts. and several people, the hydraulic lifts which support the front part of the stage being dropped below stage level.



Drury Lane Theatre: Electric Lift in Position.

APPLICATION OF THE ELECTRIC MOTOR TO WARSHIPS.

It is an unfortunate fact that a national crisis is necessary to direct the eyes of the general public to the national safeguards.

It is curious what an apathetic want of interest is displayed towards the Navy in times of peace when it is considered that in it is centred the very existence of our Empire.

In times of crisis a host of critics arise; rant and good sense is indiscriminately mixed in the public press, but sound criticism from such outside sources is, and must always be, beneficial, almost in inverse proportion to the efficiency of the matter criticised.

Judged thus by the late crisis, responsible naval experts can look back over the last few years with feelings of almost unmixed satisfaction.

Material and personnel have been particularly free from criticism of consequence; the British public stirred and awakened to a new interest have blinked their eyes and appreciated this fact that they are well served, and that at the present moment the British Navy is in the forefront alike in numbers and in efficiency.

But granting this as a whole, it cannot be denied that we are prone to fall behind in the race for improvement. Conservatism is a national defect and felt in the Navy even more keenly than elsewhere.

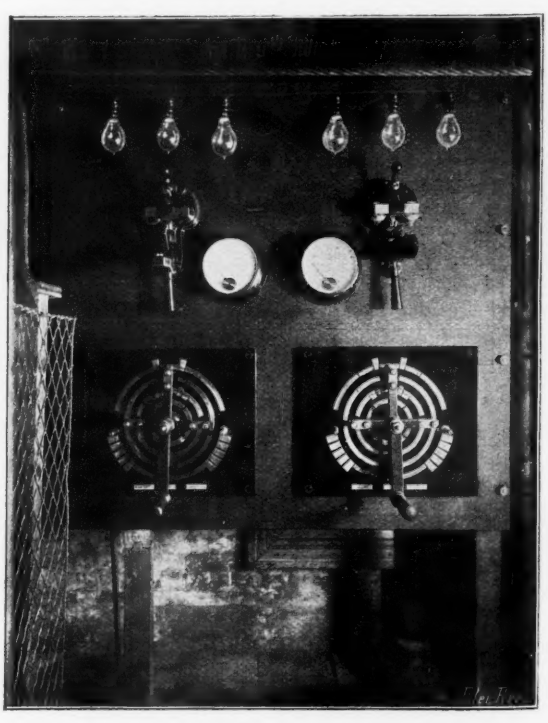
Innovations are brought in by the far-seeing only after long and arduous fight, and in extenuation it may be considered that responsible officialdom has no light task in accepting them, where the issue is so great; for where the foreigner decides on an improvement for a single ship our decision must include the same for many, so that even the ever growing desire for that most excellent quality of homogeneity in our ships is arrayed against all change. With due allowance for this and other excusing facts, the main fact still remains that we are unenterprising.

Numerous instances could be cited of this tendency to lag, which is very far from being a new thing. Our first ironclad, the *Warrior*, was built only after the French *La Gloire* was an accomplished fact, bringing the great subject of armour to the fore.

Breech-loading guns were adopted by us long after the French had supplied many of their ships with them. Many improvements in breech mechanism have been copied from that nation.

To the American, Ericsson, must be given the honour of building the first turret ship, *Monitor*. So with barbettes and many another innovation we have slowly and cautiously followed our neighbours. And this, not for want of new ideas, for many of these things had been previously conceived in England, but solely because we are deadly slow in taking up new things.

In more recent times we have the Belleville boiler. The hostility which its advocates met has penetrated the mystery of Parliamentary debate, as all the world knows, but it may not be as generally known that the French have for years



Drury Lane Theatre: The Switch Gear.

built little else than water-tube boilers, so that the cruisers and battleships of their Mediterranean squadron are nearly all fitted with them.

The Belleville boiler is now justifying itself, firstly in its incipient advantage, that of raising steam quickly. (It will be remembered that Admiral Sampson was 10 miles to the

eastward of Santiago when Cervera escaped, and out of the hunt for that reason, whereas with water-tube boilers he might have been well in it); and, secondly, in the gradual improvement of its economy.

And this latter points the moral, for most important innovations must pass through their trial stage when they are little better than the machinery which they supersede. It is only by humouring them, becoming educated in their wants, that ultimate triumph is obtained.

In peace time this transition stage is passed quietly and without comment. In time of war it might lead to difficulty. At all times of peace it is, therefore, obvious that the sooner this stage is passed the greater the state of preparedness. It behoves, therefore, to look forward at all times to the changes that may come, to regard the improvements in foreign navies, and to think generally on those points in which we show a tendency to lag behind. Such points undoubtedly exist, and one of the most important is in connection with the great modern development of electricity.

A great and ever increasing desire is exhibited in foreign navies to utilise this form of energy, and the smallest consideration of their efforts will convince the inquirer that here we are rapidly falling behind the times. The eminent adaptability of electricity for the transmission of power points it out at once as a possible means of working the outlying auxiliary machinery of a war ship.

To inquire into its relative advantages, to point out the steps we and our competitors are taking, and to briefly sketch the conditions under which our dilatoriness exists, will be the object of this article.

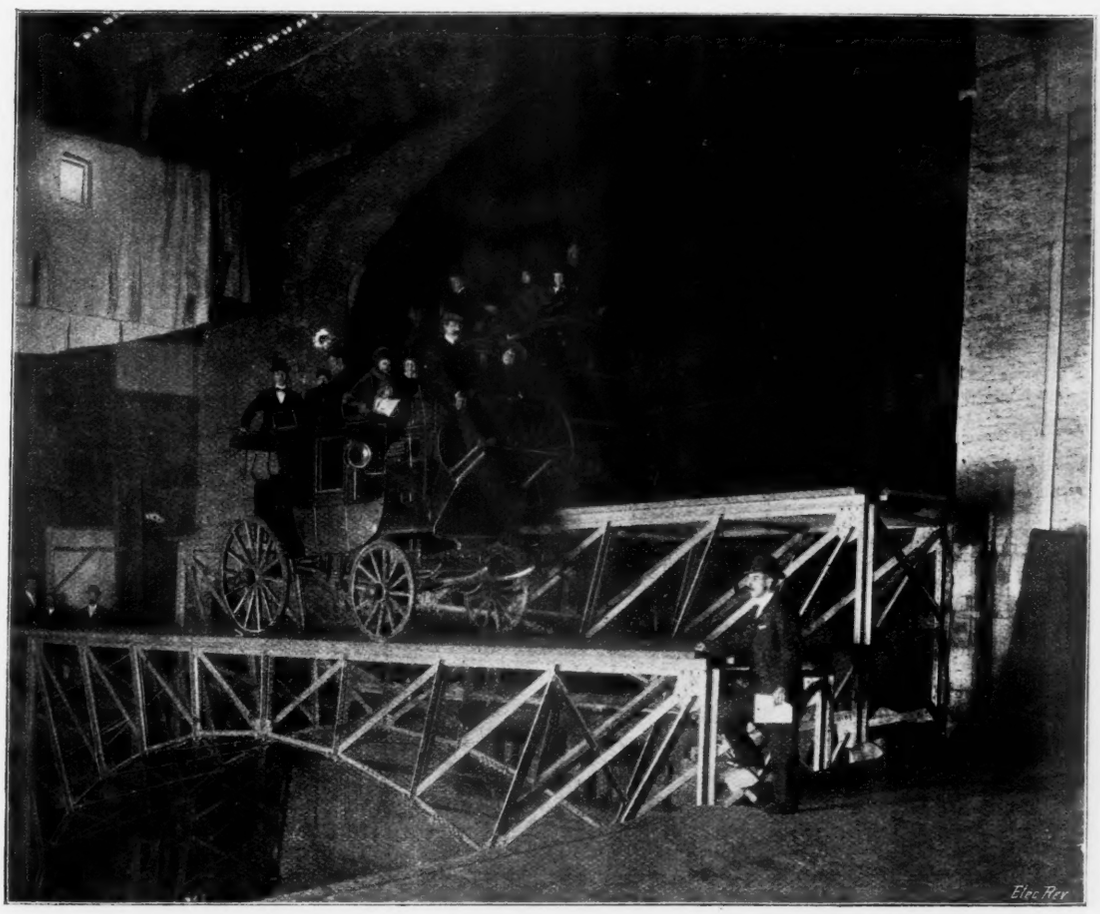
The question is a large one, there being some 30 or 40 auxiliary machines of this description in a battleship, performing the most important and necessary functions, and involving at all times a large and serious expenditure of coal.

Such machines comprise capstan engines, boat hoists, winches, ventilating fans, air compressors for torpedoes, dynamos, steering engines, ash hoists, lathe engines, and finally, and of greatest importance, the gun working machinery.

With some few exceptions, in our ships, all these are worked by steam direct except the latter which is almost always controlled by hydraulic power.

All this is placed in our ships with studied caution, steam engines and pipes necessary for fighting purposes being under the protective deck, hydraulic systems duplicated, and in all possible manner safeguarded against failure; in fact, as the result of many years' experience, the latter has been perfected almost to the extent of its capacity.

All this is good, and we may say great labour and sagacity has placed us in possession of some of the finest fighting machines afloat; but it must always be remembered that our best may be bettered, and in these days with great rapidity.



Drury Lane Theatre: Electric Lift under Load.

In electricity for the above purposes a great rival is creeping in. A rival we are seriously neglecting which bids fair to oust both hydraulics and the detached steam engine, and a rival in whose application foreigners are taking serious and successful steps.

In this matter of transmission of power to outlying machinery there are four competitors: Steam direct, hydraulics, electricity, and compressed air.

Let us deal with them comparatively; first in their most important application to heavy gun working machinery.

This must comprise the following:—

1. A very powerful and perfectly controlled turning engine for swiftly revolving the gun platform or turret.

2. An engine for working the guns and slides in a vertical plane.

3. A means for running the guns out after discharge. (It is hoped that this work will be performed by powerful springs as in the quick firing guns, but difficulty is found at present in making them of the desired size.)

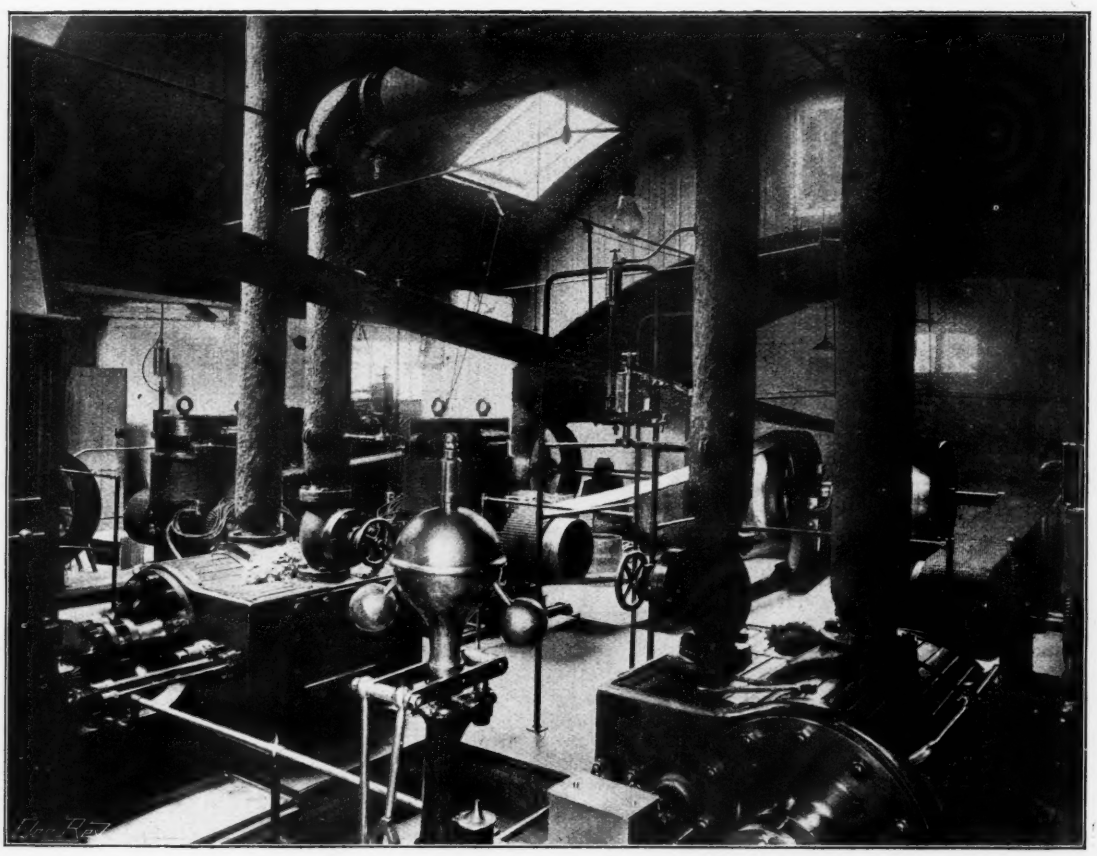
4. A rammer for loading.
5. A "hoist" for lifting ammunition from the magazine below; and some smaller engines of less importance.

It is difficult to classify the requirements of the perfect machine, especially as they differ according to actual application.

Given speed, the points to be aimed at are roughly :—

1. Freedom from failure.
2. Capacity for regulated motion and instantaneous stoppage.
3. Noiselessness.
4. Occupation of small space.
5. Protection from the effects of gun fire.
6. Economy of working and reduction of weight.

Direct steam for these purposes is far outclassed. The facts prominently brought to light in American ships during the recent war have long been known to our authorities. The danger of burst pipes, the heat imparted to compartments, and the difficulty of regulation renders its employment impossible.



Brixton.—General View of Lighting Works.

Except for motive torpedoes the employment of compressed air is up to the present visionary in the Navy, it has never received adequate trial. It has its advocates, however, who claim that it could fulfil all requirements, that the present cumbrous ventilating system could be greatly improved by its use, and that by applying it to a damaged compartment, water could be excluded to the level of the wounded part. It is, however, easy to see that defects might exist rendering it as impossible of use as steam direct.

The keenest competition for gun-working machinery lies between hydraulics and electricity, and so far, with us, the former has had it all its own way, yet electricity could be applied in all respects with as good, and in many, with far better results than its rival.

1. Freedom from failure can be equally ensured, for who can doubt the reliability of the electric motor when such countless numbers are in continual use on shore, and in case of failure the armature or magnet coils of a motor, could be replaced with far greater rapidity, than the working parts of a hydraulic machine.

2. Its capacity for regulated motion is attested most practically in the numerous favourable reports issued since its severe trial in the late war. American experts of the *Brooklyn* and other ships appear to wish for nothing better.

3. Properly geared, the electric motor can be made practically noiseless, whereas the hiss of the hydraulic system can never be eliminated, and is always sufficiently loud to prevent the passage of orders whilst the machines are in motion.

4. The space occupied might in some cases be greater, but in others it would certainly be less than the hydraulic machine, and in either case the difference would be inconsiderable.

5. Nothing could be better adapted to resist the effects of splinters, &c., than a motor of the armour clad type.

6. The question of economy is a vexed one. The expenditure of steam for gun working purposes is proportionally large whilst work is actually being performed, but the load is so infrequently on, that the total expenditure of coal is small compared with that used for distilling and other auxiliary purposes. The steam, however, is a consideration in view of the fact that it would probably be required when the main engines are working at high speed. But chiefly economy is desirable to reduce the weight of the generating machinery.

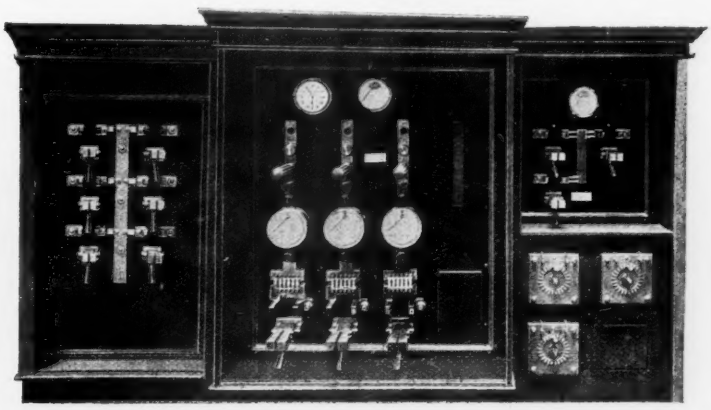
Definite data on this point, the rival application at sea, does not exist—the comparative merits of the system on shore would prove a rough guide, with this difference, that electric fittings could be installed to work with equal efficiency to machines of the same power on shore, but the principles of piston and plunger adopted in some of our hydraulic machines is obviously highly uneconomical. Moreover, waste water in the latter system has to be replaced by the ship's distillers. No criterion can be obtained from the manner in which we have so far tried electrical methods, for reasons which will be presently stated.

On the whole, no very great difference in economy or weight is to be expected between the rival plants, but it may most reasonably be supposed that what difference there is will be on the side of the electrical machines.

(*To be continued.*)

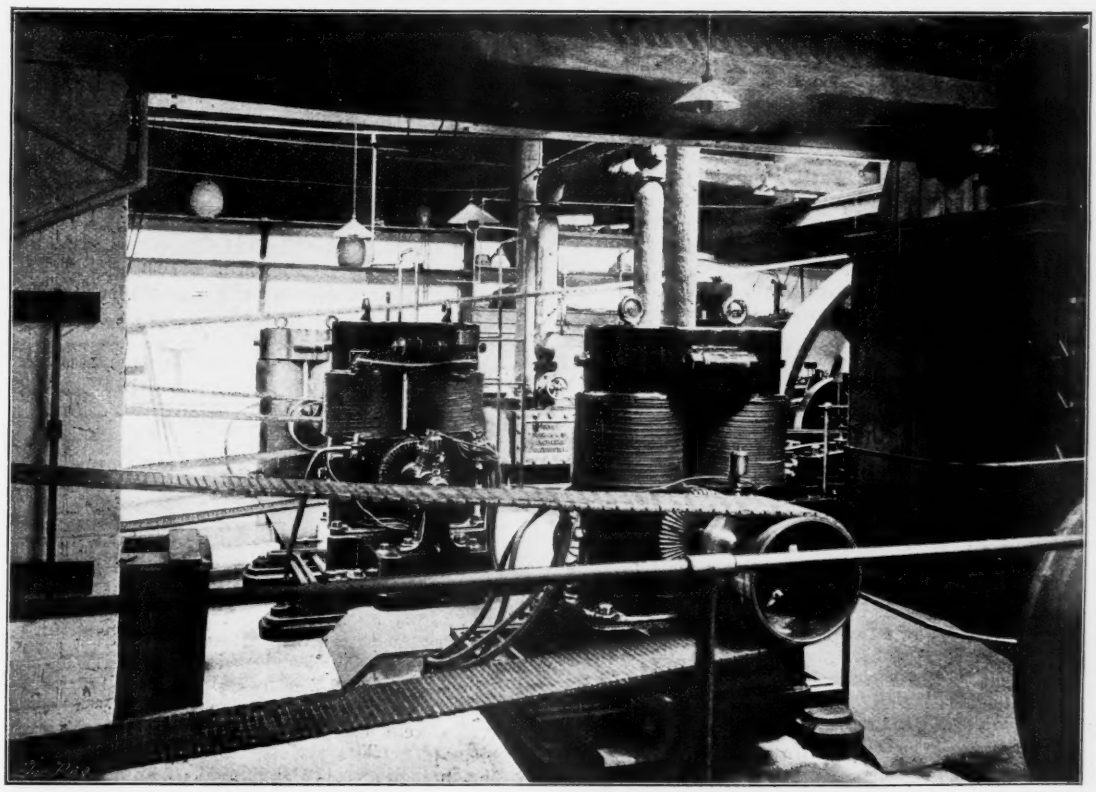
BRIXTON ELECTRIC LIGHTING WORKS.

We have from time to time made reference to the lighting of Electric Avenue, Brixton, and perhaps a few details of the plant may be interesting. It is as well to bear in mind that the plant is not in any sense of the word a public one, and, is entirely employed in lighting a private estate. Electric Avenue is contiguous to Brixton Station, and consists of a large number of shops and flats. The owner of the property conceived the idea, when erecting the buildings, that their value might be to some extent enhanced if they were lighted electrically, hence it was determined to lay down sufficient plant to illuminate not only the interior of the shops but the whole of the roadways on the estate. The brilliance of Electric Avenue must have proved, as far as the shopkeepers are concerned, an excellent advertisement, and on special occasions, such as Christmas, electric effects are created that vie almost with those occasionally produced at Earl's Court.



Brixton.—Main Switchboard.

The steam plant consists of two Lancashire boilers, 30 feet by 8 feet, the working pressure being 65 lbs. It is interesting to record in these days, when fines for smoke nuisance are all too common, that the methods adopted at Brixton are so eminently successful that it is almost impossible, even at times of full load, to detect smoke issuing from the chimney. They do not rely on smoke consumers to produce this effect; moreover, the coal is of the poorest and smallest kind; but their faith is in stoking, and the results certainly justify it. In connection with the steam-raising plant there are feed water heaters, which utilise the exhaust steam. There are duplicate gauges and duplicate safety valves on each boiler. The whole of the station is run by a horizontal engine, made by Davey, Paxman and Co.; this drives on to a countershaft, which in turn drives through link belting three Holmes compound wound dynamos, each having an output of 600 amperes at 70 volts. In addition to these is a spare dynamo of the Brush-Victoria type, driven by a Westinghouse engine, made by Alley & Maclellan. This not only fulfils the functions of a spare plant, but is also utilised to meet the extra demand that arises on the special occasions to which we have alluded. It will be seen from the illustration that the switching devices are of the most simple description, and consist of three main dynamo switches, which connect the machines on to the bus bars. The mains are partly overhead and partly underground.



Brixton.—View of Generators.

The lighting of the shops is done mainly by arc lamps, the number of incandescent lamps being comparatively small. The number of arcs is about 105, and incandescents number about 300, varying from 50 to 16 C.P. The customers instead of paying by meter, are subject to an annual charge per lamp. It should be, perhaps, mentioned that the whole of the wiring is done by the lighting department, the arc lamps were manufactured by the late Mr. John Main.

Mr. Christie is the engineer in charge, to whom our thanks are due for the foregoing information.

The Photographs are by Leighton & Co., Brixton Road.

MR. C. E. WOODS ON STORAGE BATTERIES AND ELECTRIC MOTO-VEHICLES.

THE paper read before the Chicago Electrical Association last November by the above-mentioned manufacturer of electric vehicles must, we think, have contained some data other than those given in the published report,* otherwise his audience must have been greatly puzzled to find out what number of pounds weight of battery are equivalent to the ton-mile of traction under the given conditions. Mr. Woods says:—

"There are three different batteries on the market now which seem to be fulfilling the requirements, and, as a comparison, I will take the cab battery. One make weighs 1,120 lbs. and (gives) a 36-ampere discharge for three hours. One weighs 1,500 lbs. for a 37½-ampere discharge for 3½ hours; and one weighs 1,000 lbs. for a 36-ampere discharge for three hours; and the ratios of capacities and weights are the same for all other sizes."

Mr. Woods further says:—"I sincerely hope that those directly interested in the development of the storage battery for this purpose will deliver to us some information regarding difficulties they have had to overcome." We are able, in some degree, to satisfy this requirement. One of the difficulties is to know what is meant by "complete" or "total" weight of vehicle. Is it the weight of the empty carriage? If so, how is it made complete or total, and why are not the weight of the passengers and that of the motors taken into account. If not, is the weight of the vehicle rendered complete by adding that of the motors? Passengers can hardly form part of the total weight of a vehicle; but, if they are not included in it, why is their weight not added in, to make up the total traction weight? Another difficulty is to understand what is meant by the above statement about batteries. No mention is made of any number of cells in series, nor is the E.M.F. stated. When this is the case, it is usually assumed that the E.M.F. is 2 volts, and that the cells, if there be more than one, are not connected in series.

But, according to this assumption, the specific rates of discharge and capacities of the three batteries referred to would be absurdly small. We should have:—

For battery	No. 1,	$\frac{\text{amperes}}{\text{lb.}}$	= ·0321;	$\frac{\text{ampere-hours}}{\text{lb.}}$	= ·0964
,,	No. 2,	,,	= ·0243;	,,	= ·085
,,	No. 3,	,,	= ·036;	,,	= ·108

These results are, of course, absurd, since we have traction batteries in which the specific rate of discharge approaches, or even considerably exceeds, unity, and in which the specific capacity is 5, or even 6, ampere-hours per pound. Almost obviously there must be cells in series, and these results, to be applicable to a single cell, should be multiplied by the number of cells in series. What this number is we have to find out for ourselves, or to guess at, by carefully scanning a large extent of context.

The different vehicles constructed by Mr. Woods are referred to as follows:—

No 1 equipment—Passenger capacity, two; complete weight of vehicle, 800 lbs.; weight of batteries, 440 lbs.; average miles run on one battery charge, 20; speed, miles per hour; first, 3½; second, seven; third, 14; number of motors used on vehicle, one; horse-power, 2¼; number of battery cells, 36; amperes per hour for three hours, 12; time in hours required to charge batteries, three.

No 2 equipment, designed for a top carriage or a heavy buggy—Complete weight of vehicle, 1,150 lbs.; weight of batteries, 600 lbs.; average miles run on one charge, 25; speed, miles per hour; first, 3½; second, seven; third, 14; number of motors used on vehicle, two; horse-power, three; number of battery cells, 40; amperes per hour for three hours, 18; time in hours required to charge batteries, three.

No. 3 equipment, designed for four passengers in an open vehicle, such as a trap or brake—Complete weight of vehicle, 1,800 lbs.; weight of battery, 800 lbs.; average miles run on one battery charge, 30; speed, miles per hour, first, 3½; second, seven; third, 14; number of motors used on vehicle, two; horse-power, five; number of battery cells, 40; amperes per hour for three hours, 30; time in hours required to charge batteries, three.

No. 4 equipment, designed for both commercial delivery waggons and for heavy cabs, and also applied to heavy carriages with tops—Passenger capacity for from four to eight people; complete weight of vehicle, 2,400 lbs; weight of batteries, 1,000 lbs.; average miles run on one charge, 25; speed, miles per hour; first, three; second, six; third, 12; number of motors used on vehicle, two; horse-power, 6½; number of battery cells, 40; time in hours required to charge batteries, three.

In the highest vehicle the number of cells is 36, in the remaining cases it is 40. The tested values applicable to the heavy cabs are given as follows:—

Maximum speed of vehicle, 12 miles per hour.
Total load to be carried, including four persons, 3,200 lbs.
Maximum H.P. required in motors, 5½.
Average ditto, 4.
Voltage of motors, 72.
Volts lost in motor, 8.
Maximum voltage, 80.
Number of cells, 40.
Maximum amperes required, 52 (per motor, 26).
Average amperes per motor, 22.
Mileage capacity at maximum speed, 30.
Hours' discharge, 2½.
Ampere-hour capacity required in battery, 110.
Greatest maximum effort required for overcoming inertia, and for grade climbing, 9.

The last item, we take it, means that nine times the average power is sometimes required for short periods.

Assuming that the number of cells in each of the three cab batteries above referred to is 40, the specific values become:—

For battery	No. 1,	$\frac{\text{amperes}}{\text{lb.}}$	= 1·284;	$\frac{\text{ampere-hours}}{\text{lb.}}$	= 3·856
,,	No. 2,	,,	= ·972;	,,	= 3·40
,,	No. 3,	,,	= 1·44;	,,	= 4·32

And these results, if compatible with sufficient durability, are fairly up to date.

Taking the total load as 3,200 lbs. = 1·43 ton and the mileage as 30, we have nearly 43 ton miles. Taking the weight of the accumulators as 1,000 lbs., we have $\frac{1,000}{43}$ = 23·3 lbs. of battery per ton mile.

The average H.P. may be taken as

$$\frac{72 \text{ volts} \times 44 \text{ amperes}}{746} = 4·25.$$

The H.P.-hours are 4·25 × 2·5 = 10·6,
And the H.P.-hours per ton mile = ·246,

which value agrees very well with recent results obtained in this country and in France.

* *Western Electrician* (Chicago).

THE BECQUEREL RAYS AND TWO NEW ELEMENTS.

M. AND MME. CURIE, working with M. Bémont, of the French Académie des Sciences, have recently described in the *Comptes Rendus** the properties of certain substances obtained from pitchblende, which possess, and to an enormously greater degree, the radio-activity already associated with uranium, thorium, and their compounds. Air in the neighbourhood of these bodies becomes electrically conductive, so that charged bodies are discharged, and the radio-activities were compared by the conductivity produced. Photographic plates are also affected by these substances, acting through sheets of aluminium; and, in the presence of the new bodies, barium-platinocyanide becomes luminous. These properties are shared by the Röntgen rays, by ultra-violet light after metallic reflection, and, in the case of conductivity, by flame. M. Becquerel discovered the circumstance in the case of uranium, and a peculiar radiation from

* *Comptes Rendus*, Vol. cxxvii., pp. 175, 1,215.

it, capable of producing the effects, has been imagined by, and named after, him.

M. and Mme. Curie have now obtained from pitchblende two substances, of which one is indistinguishable, chemically, from a salt of bismuth, and the other from a salt of barium. They differ from ordinary salts by their radio-activity, and are believed to contain new elements. To that associated with bismuth has been given the name polonium, in honour of Mme. Curie's country of birth, and to that with barium the name radium. Polonium is separated with bismuth from its solutions by sulphuretted hydrogen, and completely precipitated by ammonia, but no wet way was found of separating polonium from bismuth. A gradual separation was effected by repeated partial sublimation, until a substance was obtained 400 times more radio-active than uranium, though its spectrum could not be distinguished from that of bismuth. The spectrum, however, of bismuth, consists of a great number of fine lines, and its complete identification is difficult.

The salt containing the hypothetical element radium is chemically indistinguishable from barium chloride, differing from it in its radio-activity. The reasons which induced the authors to find in it a new element were shortly as follows, and the first two apply, *mutatis mutandis*, to the bismuth-polonium salt.

1. Radio-activity appears to be an atomic property of a substance, persisting through all its chemical and physical states, and as barium from other sources is not radio-active, that obtained from pitchblende, which is active, contains a different substance.

2. The radio-activity can be increased by successive fractional precipitations by alcohol from aqueous solutions of the chloride, and a chloride was thus produced, having an activity 900 times greater than uranium. This is explained by the presence of a radio-active element, whose chloride is less soluble in dilute alcohol than is that of barium.

3. M. Demarçay found in the spectrum a line not associated with any known element, whose intensity increased *pari passu* with the radio-activity in the above process of concentration. This line is attributed to the radio-active constituent.

The concentrated highly active chloride still contains a very large proportion of barium, and it is inferred that the radio-activity of pure radium would be enormous.

Polonium and radium are considerably more active than uranium or thorium, and produce photographic impressions in half a minute, for which the latter require several hours. The radiations of compounds of polonium and radium render barium-platinocyanide fluorescent, their action being in this respect analogous to that of the Röntgen rays, though considerably more feeble. Uranium and thorium under the same circumstances give no light, their action being probably too slight. The authors observe that here is a source of light functioning apparently without energy.

WHAT THE NEIGHBOURS SAY.

It is, of course, seldom that two countries agree in their modes and conditions of life or business, and one constantly therefore comes across expressions of surprise in foreign journals of the way in which things are managed or mismanaged in this country.

The *Electrical World*, in a recent issue, points out in connection with English electric traction methods two noteworthy features, wherein we are old-fashioned and ultra progressive respectively. Thus we are held up to blame because the open conduit system makes no headway whatever amongst us, and receives the keenest possible opposition and criticisms from the technical press. Our contemporary, indeed, quotes these pages as being opposed to the open conduit on account of its cost, stating that it could only prove remunerative in very crowded thoroughfares like Broadway or similar streets.

Yet, says the *Electrical World*, English engineers have a hankering after cable lines with their still wider open conduits, though we do not think that our contemporary has any right to include the Electrical Review amongst the indiscriminate advocates of cable lines. We cannot certainly altogether accept the dictum of the *Electrical World* that a cable system costs more in every respect than an open conduit electric line. It may do so in seven cases out of 10, but we doubt the remaining three in any feature, and in regard to the cost of power only, we should like satisfactory proof that as many as three (instead of seven) out of 10 cable roads are more expensive than open conduit electric.

A well designed overhead trolley system ought to be good enough for any reasonable being—not being a faddist or a member of some municipal authority.

This brings up the second noteworthy contrast between this country and the United States in regard to electric traction, and here England is considered to have gone ahead. Some of us feel pretty sure that she has gone, not so much ahead as afield, wandering away from the paths of common sense into the mazes of municipalisation, that blessed shibboleth which is unpronounceable as a rule by those who believe in it most firmly.

Although therefore our American cousins flatter us by assuming that the municipalising of tramways in England has been somewhat of a success, because of the comparative honesty of municipal life, whereas "on account of the civil service abuses in the United States it is doubtful if such a movement could be introduced safely over there for many years to come;" yet we can assure them that the municipal movement, strong and beneficent as it is in many respects, must inevitably fail in regard to the operation of electric tramways, for the simple practical reason that such lines of their own essential nature are bound to spread all round far outside the limits of any municipal authority, however great the latter may be, and however important in its own estimation.

To secure uniformity and ready convenience of working for the public benefit, these networks must therefore be operated by some independent interest outside of the various local authorities concerned. The latter may carry out the work of construction, and may retain full control of roads and streets in their respective areas; but, if one may safely reason from natural laws rather than municipal enactments, the big towns of this country that are just now so exceedingly proud of their so-called municipal tramways, will soon find these lines forming in each municipal area but a small portion of a big network which, as time goes on, will grow into a veritable street railway system, rivalling in importance for short distance rapid passenger traffic the great main line railways.

The municipalities are no more justified in taking over and working tramways by electric traction outside their own districts than they would have been 60 years ago in absorbing the infant railways; and, in regard to the latter, there is no alternative to working them by means of private companies under due restriction, except the nationalisation of all the lines.

By the time that the State is ready to nationalise the railways this generation will have passed away; and the further step of nationalising the tramways of the country is so remote as to give Mr. Marconi, his heirs, executors and assigns for many generations to come, the opportunity of inventing some individualistic system of electric traction whereby every man shall have his own invisible trolley car, without requiring to pay vulgar fares into a tin box for relief of the rates.

THE FATAL ACCIDENT AT SOUTHAMPTON.

Major Cardew's Report upon the Inquiry into a Fatal Accident from Electric Shock at Southampton on December 12th, 1898.

To the Assistant Secretary,
Fisheries and Harbour Department,
Board of Trade.

Sir,—I have the honour to report that, as appointed by the Board of Trade, I held an inquiry on the 21st inst. into the cause of a fatal accident to Walter Day, a jointer in the employment of Messrs. W. T. Glover & Co., who are the contractors for the street work in connection with the extension of the electric light supply at Southampton.

The inquiry was held in the Council Chamber at Southampton. The town clerk represented the Corporation of Southampton, who are the undertakers. Mr. J. D. Bassitt, solicitor, appeared for Messrs. Glover & Co, and for Mr. J. Brooking, their local superintendent.

I attach my notes of the evidence given at the inquiry, and a transcript of notes taken in shorthand, kindly forwarded to me by the town clerk.

There does not appear to be any doubt as to the facts of the case, which are briefly as follows:—

The Corporation, for the purpose of extending the area of their electric supply, are laying down a system of high pressure mains to supply transformers placed in street boxes, and also a system of low pressure mains, to serve consumers from these transformers.

The contractors for the street work are, for various reasons, behind time, and in order to carry out promises made to intending consumers, who were waiting for the light, the Corporation unfortunately commenced to supply before the laying of the high pressure mains was completed and proper joints made. The mains were still in charge of the contractors, who had working parties engaged upon them at the time, while the arrangements for supply were naturally under the control of the engineer to the Corporation, a division of responsibility which in itself is likely to lead to mistake and danger.

The high pressure mains are concentric lead-covered cables laid in earthenware "ways," the outer conductor being connected with earth at the generating station, and the inner conductor being therefore charged to the full pressure (2,000 volts) from earth.

The low pressure mains are almost exactly similar in appearance to the high pressure, and are laid in similar "ways" alongside of the

high pressure, where they follow the same route. The separate lengths of main are to be connected together by means of cast-iron junction boxes, but as these had not arrived, temporary connections had been made in three street boxes by means of pieces of single cable connecting the respective inner conductors and outer conductors, the joints being covered with India-rubber tape.

In the box where the accident took place branch connections were made from the high pressure mains to two street transformers, and the work had evidently been hurried, the ends of cables and connections crossing each other and presenting the appearance of a tangled mass. Besides the high pressure mains there were three low pressure mains passing through the box.

Between 3 and 4 p.m. on the 12th inst. a party of the contractors' employés were engaged in passing rods through the cable ways in order to draw in cables in the upper portion of the High Street, and one of them, Henry Flux by name, lifted the cover of the street box mentioned above in order to give notice when the end of the rod appeared. He saw sparking taking place between one of the cable ends and the side of the box, and pointed this out to Mr. Brooking, the superintendent, who got into the box and examined the fault, receiving a slight shock when he took hold of the insulating covering of the inner conductor. This was no doubt due to surface leakage. By hastily tracing out the faulty cable with his eye, he had come to the erroneous conclusion that it was a low pressure cable, being misled by the confusion in the box, and, strangely enough, the shock he received confirmed his mistake. He therefore asked for some rubber strip to repair the fault, and as there was none available, went to find the jointer who had made the joints, and instructed him to re-tape the joint. The electrical pressure was on at the time, although it could easily have been switched off at the generating station.

Brooking was warned twice by Mr. Shepherd, the clerk of works, to be careful, as the fault might be on a high pressure main, but persisted that he had identified it to be low pressure.

The jointer, Walter Day, went at once to the box, got into it, handled the cable carelessly, and received a fatal shock. He was at once dragged out by Brooking and Shepherd, who tried artificial respiration, and fetched a doctor, but life was extinct.

This accident greatly resembles the recent fatal acident at Chelmsford; in both cases a temporary connection to the inner conductor of a concentric system of mains proved deficient in insulation, and in both cases the breakdown was the natural result of the very imperfect nature of the joint, and of the use of single cable connections to the inner conductor.

On several occasions I have pointed out the danger incurred by such connections, which, moreover, are expressly forbidden by the following conditions attached by the Board of Trade to its consent to the connection with earth of the outer conductors of the system in this and all similar cases, viz:—

"1. That the high pressure mains and any service lines in connection therewith, be concentric throughout.

"2. That the outer conductor in all cases form a complete metal sheathing round the inner conductor."

In the concentric system, as properly carried out, there are two earthed metallic shields surrounding the inner or charged conductor, and any breakdown of the insulation of the latter must inevitably cause a short circuit, which will operate the safety fuses and cut off the pressure automatically. Even where the concentric arrangement of conductors is not carried out at the joints, as, in my opinion, it should be, a cast-iron joint box is always provided and thoroughly earthed on to the outer metallic protection of the main. If in any part of the circuit the insulating covering alone is relied upon for the safeguarding of the charged conductor, the system at once loses its security and becomes decidedly more dangerous than one in which separately insulated conductors are used throughout. This is now fully recognised by all engineers of experience.

There are two dangers disclosed by this inquiry against which the Board of Trade should provide in considering new proposals for supply at high pressure.

These are, first, the danger that high pressure mains may be brought into use for supply before they have been completely laid, properly jointed, examined, and tested, and while they are still in charge of other parties than the undertakers.

Secondly, that high pressure mains may be mistaken for low pressure mains passing through the same street box if the different mains are not readily distinguishable from each other.

With regard to the first of these dangers, the Board of Trade regulations certainly provide that:—

"A high pressure circuit shall not be brought into use unless the insulation of every part thereof has withstood the continuous application, during one hour, of pressure exceeding the maximum pressure to which it is intended to be subjected in use, that is to say, in the case of every electric line a pressure twice the said maximum pressure, and, in the case of every machine, device, or apparatus, a pressure 50 per cent. greater than the said maximum pressure.

"The undertakers shall duly record the results of each test."

This test had not been carried out in this case. It would probably have at once developed the fault, but might not have done so, and I think it will be desirable to definitely forbid any attempt to supply at high pressure through unfinished mains, and before the mains have been thoroughly examined and taken in charge by the undertakers.

It is probable, as stated by the engineer to the Corporation, that great pressure was brought to bear on him to induce him to commence supply on these mains against his better judgment.

It should also be noted that Mr. Brooking stated that he protested against supply being commenced in the unfinished mains, but had yielded to an earnest request.

I fear there is a distinct tendency in the case of electrical undertakings managed by municipalities to unduly press the engineers to start the works before they are properly complete, and it would strengthen the hands of these engineers if the Board of Trade distinctly forbid any makeshift arrangements.

The second danger is one which has only lately arisen, but which certainly, in this case, has proved to be a very real one.

It can, of course, easily be provided against, and the attention of the manufacturers, will no doubt be directed to this point, which appears to have been overlooked.

To sum up, I am of opinion that Walter Day lost his life from electric shock received while carrying out instructions given under a misapprehension by his superior, whereby he was placed in a position of extreme danger; that the high-pressure mains from which the shock was received were not in a proper and fit condition to be brought into use for purposes of supply; and that the regulations and conditions imposed by the Board of Trade on the undertakers had not been complied with in the case of these mains.

I have, &c.,

December 27th, 1898. P. Cardew.

A CIVIL ENGINEER ON THE METRE.

A civil engineer resident in Brazil writes to an American paper suggesting a universal "metre" of 40 inches in place of the existing one of about 39⅜ inches. Had it not been for a French ideal it seems very possible that the metre might have been fixed at 40 inches. This would have been a useful and convenient standard for all countries, and our standard yard would have been simply 10 per cent. less, a beautiful decimal discount for those who are so enamoured of decimals. The millimetre would then have been exactly the 25th part of an inch.

Advocates of one system or another are very apt to imagine that people are able to grasp certain ideas of value when expressed metrically or per foot. Now this is not so. We doubt if anyone really grasps the meaning of a pressure of steam of so many pounds per square inch. They do not. True, a statement of a pressure of 75 lbs. per square inch conveys no idea of safety or danger to a layman, whereas it does so to a steam engineer for he at once recognises it as the pressure at which a 7 feet boiler of double riveted $\frac{7}{16}$ iron may be worked, and he has at once a sort of datum line on which to make rapid mental approximations when other pressures are named.

It is all a matter of experience. Were it not so we should not find engineers making calculations of great length and taking no notice of decimal points at all, but simply pointing off the correct result at the finish. The pointing off is not done by guess but by experience. A figure, 219,875, representing a rate of coal combustion per unit grate area will be called 22 lbs., not 2·19 nor 219·8, but this is because the calculator knows it will be about 20. The huge and foolish errors in engineering are made by scientifically educated men before they have become familiar with the figures of practice. It is such men who will work out their tons of putty for cover luting. Yet they are familiar enough with weights and measures in all their details. We read a good deal about loss of trade through our English system, and calls are made for compulsory change. Anyone who does business abroad need not be put to any great expense to double figure their catalogues and drawings. We have before us some blue prints of an English engine builder, which are thus figured. Conversion of measures is easy enough, but surely if anyone ought to change it is the metrical people who could conform to the measures of England and America by adding less than $\frac{1}{8}$th of an inch to their already incorrect metre. The new metre would be so little larger than the old one as to make comparatively little difference in technical records. The most valuable records are in our own language, and to adopt the metre would spoil the whole irretrievably for the next generation. Metrical advocates appear to assume that the English foot cannot be decimally divided. It will not be for vulgar use because decimal divisions are impracticable. Decimal arithmetic is all very well in the laboratory, but in the laboratory we don't use a pair of shop scales, and yet one might as well argue for a chemical balance in the kitchen as for laboratory measures and arithmetic. We want—to paraphrase a political phrase—men, not measures. If there is any slipping away of English trade it is not because of any difference of measures. Were this so, the Danes would not be sending over here so much dairy produce. We suppose they can cope with the difference of measure, and our own manufacturers are perfectly able to cope with foreign measures if it suits them to do so. If weights are to be invoiced as kilogs. there is no difficulty in reading off the result directly on a double graduated rule. The best system for weights is to use the pound as the Americans do even in giving the weight of a locomotive or train. Invoices would be much simplified thereby, and conversion to kilos. would be easy and rapid. But are England and America and Russia to be dragged in the wake of the Latin races in sacrificing their measures. Germany, it is true, had the metre forcibly imposed upon it by conquering France, but no success was possible as regards Russia and England, and the cost would be terrific. When boiler plates and bridge iron can be obtained rolled to fractions *full* and *bare*, we think it is the iron manufacturers own fault if he cannot equally quote for plates of 12 or 13 mm. which represent a full and bare half inch, for example. If pipe makers refuse to comply with a specification in metrical measures to-day, we expect it is because they are too full of work to do so. We know of cases now where orders of months ago are still undelivered. Ordinary pipes are not made to such dead lengths that they cannot be equally well fitted out with millimetres as with inches.

ELECTRIC LIGHTING NOTES.

(*Continued from page* 164.)

Manchester.—The General Purposes Committee of the City Council has resolved to oppose the following Bills:—General Power Distributing Company, Lancashire Electric Power Company, South Lancashire and Cheshire Electricity Company, Leicestershire and Warwickshire Electric Supply Company, Midland Electric Power Distribution and Lighting Provisional Order. Also the National Telephone Company (No. 1) Bill, National Telephone Company (No. 2) Bill, and the Telegraph Act (1892) Amendment Bill.

Marylebone.—As the Vestry last week did not arrive at a decision on the urgency report of the Electric Lighting Committee, it is probable that the Vestry's Bill will have to be postponed for another year. To put the matter as briefly as possible, it may be mentioned that the Committee recommended the Vestry to omit from its Bill the clause proposing to compulsorily purchase the Marylebone section of the Metropolitan Electric Supply Company's undertaking, the company on its part agreeing to withdraw its memorial against the Bill on standing order proofs. Mr. Brooke-Hitching, who moved the adoption of the report, said that only by agreeing to that course would it be possible to save the Bill. An exciting discussion followed, and an amendment to refer the report back for the Committee to submit the results of negotiations with the company for the purchase of its undertaking was, on a division, rejected by 19 to 18 votes. A further amendment was about to be proposed when the debate stood adjourned in consequence of the bye-laws. It is believed the Bill will be wrecked owing to the Vestry not having come to a decision at that meeting.

The Bill promoted by the Vestry contains a clause which it would be hard to beat. The clause provides that in the event of the Vestry and the company not arriving at an agreement within 12 months from the passing of the Bill, the former shall be authorised to purchase the latter's undertaking on the same terms as would prevail at the expiration of the 42 years allowed by the Act of 1888.

Melbourne.—A correspondent says:—"The complications which have arisen in the electric lighting of Melbourne and its suburbs are to find a natural solution in the purchase by the City Council of the rights of the companies which contribute to the lighting of the city. When the Council established electric lighting works, the New Australian Company, the A. U. Alcock Company, and Messrs. T. T. Draper & Co., who were already supplying electric light in the city and suburbs, received notice that the area of their operations within the city would not be extended. Opposition was shown to this restriction, and considerable discussion ensued, with the result that the Council entered into negotiatons for the purchase of the several interests. In the meantime, the English Brush Company had made overtures for the business of the New Australian and A. U. Alcock companies, and the discussion was further complicated by proposals for joint municipal purchase and management of the wholé of the electric lighting both in the city and the suburbs. The end of it all was that the Melbourne municipal authorities decided to confine their attention to the boundaries of the city. The sum of £40,000 was agreed upon with the Brush Company as the valuation of those powers of the Alcock and New Australian companies' undertakings situate within the city, and an additional sum of £15,000 was put down as the value of the works of Messrs. Draper & Co., which are wholly confined to the city. When the last mail left the arrangement only awaited the formal approval of the City Council, which it was anticipated would be given unhesitatingly."

Perth.—The Police Commission last week had a discussion about the appointment of a consulting electrical engineer to advise in connection with carrying out the provisional order. In the end Mr. W. C. C. Hawtayne was appointed.

Sheffield.—The electric light is to be introduced into the Reform Club. The money is being got together by subscriptions.

Shoreditch.—The number of units sold by the Vestry for the last quarter of 1898 was 313,558, against 203,892 in the previous three months, and 182,584 for the quarter ended at Midsummer. The Lighting Committee says that this growing demand fully justifies the capital expenditure involved in the new generating station. The Board of Guardians are to invite tenders for carrying out the work, and supplying materials for the wiring, &c., of the Workhouse, Infirmary, casual wards, dispensary, and offices, ready for the supply of current from the mains of the Shoreditch Electricity Works.

Siam.—Under the style of the Siam Electricity Company, Limited, a company has been formed in Copenhagen, with a capital of £33,800, with option to increase the capital to £100,000. The company has secured a concession for all electric undertakings at Bangkok, but the capital is principally Danish, and all the gentlemen interested in it are Danish. *Engineering* says that the company has bought from an American gentleman his rights at Bangkok, and it is intended to extend the operations also to other parts of Siam. Messrs. Burmeister & Wain, of Copenhagen, and Messrs. Siemens & Halske, of Berlin, will jointly supply plant.

Southport.—A Local Government Board inquiry was held on 24th ult. into the Council's application for a £3,500 loan for electric lighting purposes. The sum includes mainly the provision of reserve water for condensing purposes, the feeding of the boilers, and of providing for the cooling of the condensing water discharged from the engines. Under the present circumstances, the water occasionally runs short, and to prevent this it is proposed to make a reservoir holding about a million gallons of water.

Teignmouth.—Some little difficulty has arisen in connection with the application of the District Council for an electric lighting order owing to the fact that the broad expanse of the estuary of the Teign divides the district. The Council wish to make the order applicable not only to the town but to Shaldon, which is on the south side of the river. This has brought up as opponents the Harbour Commissioners who want to be assured that the laying of a cable across the river will be no hindrance to navigation, and the Bridge Company, who are seeking protection for their interests. A special meeting of the Council was held last week to consider clauses drafted by Mr. Kennedy, the Parliamentary agent, to meet these objections. One or two of the members were disposed to drop the Shaldon portion of the scheme, but on the assurance of the clerk that the new clauses would probably meet the difficulty, it was decided to proceed with the application for the order for the whole district.

Wallsend.—The District Council discussed clauses in the Walker and Wallsend Gas Company's Electric Lighting Bill last week, and it was resolved that "while favouring the introduction of electricity, they take counsel's advice as to whether the interests of the Council and ratepayers were properly safeguarded." Councillors do not seem to have made up their minds yet upon the question of municipal working.

Walsall.—About 10 p.m. on 25th ult. the electric light suddenly went out. Considerable inconvenience was caused, especially at the places of amusement.

West Ham.—With reference to the failure for half-an-hour of the electric light supply for a number of shops along the Broadway, Stratford, reported in our last issue, Mr. A. J. Abrahams, assistant engineer at the Leyton electricity works, informs us that the Broadway, Stratford, is not supplied from that station, but from West Ham. He adds that the lights have *never* failed since supply was commenced at Leyton. We are pleased to make this correction.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Aberdeen.—On 24th ult. a deputation went to Glasgow and inspected the electric tramway system. Upon their departure from Glasgow they were said to be impressed in favour of the trolley.

Barcelona.—A financial daily says that negotiations have been entered into for the sale of the Barcelona Tramway Company's undertaking at Barcelona.

Cardiff.—The Tramways Sub-committee has submitted a report on various forms of tramway traction. The borough engineer is to go to Bristol to inspect a model of a system of underground traction by Mr. Albert R. Weight, for which it is claimed that the cost of construction is £1,000 per mile less than for the trolley. The Tramways Committee has resolved to report to the Council in favour of the overhead wire system.

Coatbridge and Airdrie.—This light railway Bill has been found not to comply with the standing orders, as proper plans were not lodged by November 30th.

Darlington.—On 26th ult. Mr. J. Clifton Robinson, managing director, and Mr. Holmes, engineer of the Imperial Tramways Company, visited Darlington, and met the sub-committee of the Streets Committee. The question of the extension of the tramline was considered. The whole scheme would involve over 6 miles of line instead of 2½ miles, which is now about the extent the tramline covers. The work, it is stated, would occupy four months. If an arrangement were come to, it was pointed out the standards which carried the cable might be used for electric lighting purposes when the new installation at Darlington takes place. It was stated that the cable might be brought along from Stockton, and in that case a service of trams to that town might be introduced either casually or otherwise. The Committee will duly consider the matter, and a fuller statement of the proposals will be sent to Darlington Corporation. The town clerk has received the formal application from Mr. Clifton Robinson on behalf of the Imperial Tramway Company. A committee has been going into the proposal.

Dundee.—The Tramways Committee of the Town Council has before it at present special reports on the merits and demerits of the proposed cable tramway, by Mr. Fisher, tramway manager, and Mr. Wm. Mackison, burgh engineer. Mr. Fisher is not favourable to the cable system, but quotes many points in favour of the overhead electric wire system. Mr. Mackison, on the other hand, reports in favour of the cable method. The Council held a special meeting (sitting in committee) on Monday to discuss the reports.

Glasgow.—A sub-committee of the Tramways Committee is meeting with the Electricity Committee with a view to coming to an agreement as to which committee shall furnish current for the extensions which are to be made of the electric tram system; and also appointing an expert to guide them.

The Tramway Committee last week adopted the recommendations *re* electric tram extensions contained in Mr. Young's report printed in our last issue.

On 24th ult., says the *Glasgow Evening Times*, an incident occurred on the Springburn electric car route. About 11 o'clock the power on the inward line suddenly failed in the neighbourhood of Hanover Street, and the cars on the journey to the city were brought to a standstill. On the outward route the power was maintained, and as long as cars were available the traffic was continued from Mitchell Street terminus to Springburn. The supply of incoming vehicles was, however, soon exhausted, and complete cessation of traffic followed. The electrical staff of the department were at once communicated with, and after testing the lines they were able to remove the fault, which was due to the disconnection of a feeder, and to restore the supply of power. Something like an hour, however, was occupied in the operations, and meantime a large number of cars had come to a stand in the neighbourhood of the block.

Hanwell-Ealing.—The Hanwell District Council is asking the Ealing Council whether it would be disposed to combine in constructing an electric tramway from Acton boundary to Hanwell.

Italy.—The experiments with electric traction on the Mediterranean Railway between Milan and Monza are now in progress. Each auto-motor carriage is capable of accommodating a maximum of 100 passengers. Each car is fitted with two Schuckert motors, while the accumulators, which consist of 130 elements, are of the Hensemberger type, have a capacity sufficient for four journeys between Milan and Monza—two outward and two return. The vehicles have been built by Messrs. Pondona, Comi & Co., of Milan. The accumulators were supplied by Messrs. Hensemberger & Co., of Monza, while the motors and other electrical apparatus have been supplied by the Milan branch of the Electricitäts Gesellschaft (Schuckert), of Nurembourg, Germany.

Liverpool.—Increasing traffic renders new cars necessary, and the Tramways Committee recently resolved to advertise for the construction of 80 cars with outside seats, "such as would be serviceable on the electric tramlines." In the meantime six new cars are to be constructed at the Corporation works in Lambeth Road, and 12 ordinary cars are to be there converted into trailers. The above decision is, however, altered by Wednesday's important discussion at the Council meeting on the subject. Tenders are to be invited for 20 motor cars of the same type as the 12 already ordered from the British Thomson-Houston Company, to be ready by June 1st. We shall report the discussion at greater length next week.

Manchester.—On Wednesday the City Council approved of a recent resolution of the Tramway Committee affirming its opinion that the overhead trolley is the best for Manchester. An amendment to try the conduit on one section was rejected

The Metropolitan Railway and Electric Traction.—Mr. J. Bell, the managing director of the Metropolitan Railway Company, addressing the shareholders last Friday, said that as to the use of electric traction on their railway, they were unable to push on with the matter as fast as they could wish, but the engineer reported that he would be ready to carry out the full experimental trial in nine months' time.

Newcastle.—The City Council on Wednesday considered a report from the Tramways Committee, giving an account of their recent visit to different cities where electric and cable trams are worked. The report will recommend the Council to adopt for Newcastle the overhead trolley electric system, also that a consulting expert be engaged to carry out the work with all possible speed. The committee further recommend that the present tramways company be requested to allow the Corporation to carry on the work where it affects their lines, even before the lease expires, so as to get the work advanced as far as possible. The Tramways Committee is consulting with the Lighting Committee as to the advisability of lighting the streets by electric lamps fitted upon the trolley poles.

Southampton.—In the Queen's Bench Division last week, before Mr. Justice Bruce and Mr. Justice Ridley, sitting as the Divisional Court, a special case, stated by the umpire, Sir Henry Oakley, in an arbitration between Southampton Tramways Company and the Corporation of Southampton, for the purpose of determining the price which the Corporation should pay to the company for the acquisition of their undertaking was presented for consideration. After hearing counsel's arguments at considerable length, their Lordships reserved their decision.

Southampton.—The Council has approved of the Tramways Committee's instructions to Messrs. Kincaid, Waller & Manville to at once prepare and submit for the consideration of the Committee detailed specifications and conditions for tenders for the whole of the work referred to in the adopted report. As the Corporation have decided to work the tramways by electricity, this Committee has requested the Electric Lighting Committee to forthwith take steps for providing the necessary plant for electric traction.

Stourbridge.—Last week Sir Courtenay Boyle heard an objection to the confirmation of a light railway order for the construction of an electric tramway in the Black Country, between Stourbridge and Kinver, which had been sanctioned by the Light Railway Commissioners, who had put in a clause that the promoters should purchase certain parts of the land by the side of the main road, in order to widen the road and make it safer for the public. The objection having been disposed of, the clauses were discussed, and the order will be confirmed in due course.

Swansea.—Tenders have just been invited for erection of a power house, &c., for the British Electric Traction Company, Limited.

TELEGRAPH AND TELEPHONE NOTES.

African Trans-Continental Telegraphs.—In an article on "British Communications in Africa," the *Times* refers to Mr. Rhodes's present visit to this country in connection with the great railway and telegraph schemes from South to North:—"The trans-Continental telegraph is practically Mr. Rhodes's own private enterprise. The greater part of the cost is paid from his own pocket, and the scheme can be completed without public help. The telegraph line is now believed to be within three years of its completion, and though the course of telegraph and railway will not be absolutely indentical, the knowledge of the country which has been acquired in the construction of the telegraph line will be of great service in the building of the railway line. The total length of telegraph wire which will stretch from the Cape to Alexandria when telegraphic connection with the Egyptian system has been made will be 6,669 miles. Of this the Cape system to Mafeking supplies 870 miles; the Egyptian system, if carried to Fashoda, will supply 2,090 miles. Upwards of 3,500 miles represents the gap in the connection left for Mr. Rhodes and the Chartered Company between them to fill. The Chartered Company is responsible for a section from Mafeking through the southern portion of its territories. The African Trans-Continental Telegraph Company, of which Mr. Rhodes is the founder and principal shareholder, has undertaken to construct 2,725 miles, connecting Salisbury, the capital of Rhodesia, with the southern boundary of the Sudan. Thus we get the whole telegraphic system between the Cape and the Mediterranean coast divided into three sections—the South African, the North African, and the trans-Continental. The principal stations of the trans-Continental telegraph line from Salisbury northwards will be Tete, on the Zambesi; Blantyre, the capital of Nyasaland; Karonga, at the north end of Lake Nyasa; Abercorn, at the south end of Lake Tanganyika; Pamlilo, on the western shore towards the southern end of Tanganyika, where British Central Africa meets the border of the Congo Free State; Uvira, in the Congo Free State, near the north end of Lake Tanganyika; Fort George, upon the north-western shore of Lake Albert Edward; a point not yet decided at the southern end and another at the head of the Albert Nyanza; Lado, Abu-Kuka, and Sobat, upon the Nile. There are intermediate stations of which the names are even less familiar to the public than those which have been cited, and the line will be divided into sections averaging about 200 miles in length, with an inspector and an efficient staff of line men to every station. Branch lines will also be constructed to important points, as for instance from Fort George to Uganda on the one side and to Stanley Falls upon the other, and from Uvira, at the head of Lake Tanganyika, to Mwanta, at the foot of Victoria Nyanza. The portion of the line which is now completed and in working order is from Salisbury to Karonga, at the north end of Lake Nyasa. A message was the other day received at Cape Town from Karonga within three hours of its despatch. The section from Karonga to Abercorn, at the south end of Lake Tanganyika, is nearly finished, and the further section to Pamlilo, on the Congo Free State border, has been surveyed. The second object of Mr. Rhodes's visit to this country and of the journey to Egypt which he proposes to take next week, is to obtain permission to start simultaneous work upon the telegraph line from the northern end at Sobat, whence material for construction can now be more readily conveyed than it could be from the southern end. Construction will at the same time be pushed on from the south, and the two ends will presumably meet at Fort George, upon Lake Albert Edward. The trans-Continental telegraph line may therefore be looked upon as in a fair way to bring to speedy fulfilment that part of the promise of through communication from the Cape to Cairo which it contained."

It is stated that Colonel Frank Rhodes, Mr. Arnold Morley, Earl Cairns, and others, have gone to Egypt in connection with the trans-continental telegraph.

Hawaiian Cable.—Mr. Corliss, of Michigan, has introduced a Bill in the House of Representatives to secure the construction of a cable connecting the mainland of the United States with Hawaii, the Philippines, Japan and China. It authorises the President, says the *Electrical Engineer* of New York, to cause the cable to be laid, and an appropriation of a sufficient sum to secure a cable that will carry at least 15 words a minute. When the cable is completed it will be turned over to the Post Office Department and operated as part of the postal service. General Greely, of the United States Signal Corps, estimates the cost of a cable from San Francisco to Luzon at about $10,000,000. The route will probably be from San

Francisco to Wake Island, to Guam and to Manila. The route has never been surveyed further than Wake Island. The Spaniards declined to sell one of the Carolines, which extend 2,000 miles east and west. This would have been the best and cheapest route, but the Government will proceed by the route noted. The intention of the Government to undertake the San Francisco-Manila cable is foreshadowed by its determination to connect the Philippine Islands by cable as speedily as possible.

Interruptions to Australian Trunk Landlines.—We learn from the Australian press that the main landline which connects Port Darwin with Adelaide was interrupted for a couple of days on December 18th last, and that traffic had to be diverted *viâ* the West Australian line. Our readers will remember that the Port Darwin line is that in which Sir Charles Todd has asked us to have such faith. An examination of the grounds on which he has based this request has long ago proved to the public that such a faith would be quite out of place, as it is impossible to put any confidence in either of the Australian trunk landlines.

The National Telephone Company's New Bills.—Mr. Campion, one of the examiners of private Bills, had before him on 27th ult. the memorials of the Corporations of Glasgow and Edinburgh alleging non-compliance with the rules of Parliament in the case of the three new Bills of the National Telephone Company. After hearing the objections at length, it was decided to report Nos. 1 and 2 Bills as having failed to comply with the Standing Orders of Parliament, and they will have to go before the Standing Orders Committee, who will decide whether or not the rules in the cases specified shall be dispensed with.

Submarine Cable Concession.—A daily paper says that Dr. Zander, director of the Anatolian Railway, has obtained a concession for a submarine cable from Constantinople to Kustendji.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Amazon Company's cable—		
Cable beyond Gurupa ...	June 11th, 1898 ...	...
Para-Maranham	Nov. 14th, 1898 ...	...
West Indies—		
St. Kitts-St. Thomas ...	Jan. 26th, 1899 ...	Feb. 1st, 1899.
St. Kitts-Antigua ...	Jan. 26th, 1899 ...	Feb. 1st, 1899.
Landlines.		
Majunga-Tananarive ...	Jan. 26th, 1899 ...	Jan. 26th, 1899.
Indo-European lines (between Kertch and Soukhoumkale)	Jan. 23rd, 1899 ...	Jan. 23rd, 1899.
Lines near La Paz, Bolivia	Feb. 1st, 1899 ...	...

The Telephone Question.—Last week the Court of Common Council resolved, on the motion of Mr. Morton, "That a conference of local authorities in London be held at the Guildhall, on a date to be fixed by the Right Honourable the Lord Mayor, to consider the National Telephone Company's Bills now before Parliament; that each road authority be invited to send three delegates to such conference; and that it be referred to the Streets Committee to make the necessary arrangements accordingly." Mr. Morton said the three Bills which were promoted by the National Telephone Company proposed to take away from a body like the Corporation its rights in regard to the opening of the streets, and he hoped the municipal authorities would combine against the attempt to be thus made.

At Manchester last week a meeting of the General Committee for obtaining an independent telephone service in Manchester, Salford, and district, was held to take into consideration the refusal of the Postmaster-General to grant a license to the Mutual Telephone Company, and to decide upon the action to be taken. The chairman, in a report, explained that capital was subscribed, 2,000 instruments ordered, and everything made ready by the Mutual Telephone Company established in Manchester, but on application for a license, which was supported by 88 municipal authorities, 190 urban district councils, 16 chambers of commerce, and 10 trade protection societies, was declined by the Postmaster-General. A resolution pointing out the desirability of a license being granted to the Mutual Telephone Company was passed. It was resolved that a deputation, consisting of representatives of public bodies in Manchester and Salford and the Committee, should wait upon Mr. Hanbury, M.P., and place before him the views of the commercial area, of which Manchester forms the centre.

Several additional Chambers of Commerce in the provinces have been passing resolutions favouring Government control of the telephone service.

The Court of Common Council has resolved to oppose the following Bills in Parliament:—National Telephone Company Bill (No. 1), National Telephone Company Bill (No. 2), Telegraph Act, 1892 (Amendment Bill). It has further resolved to present a petition in favour of the Glasgow Corporation Telephone Bill, and to ask the City members to support the same in Parliament.

U.S. Government Cable Steamer for the Philippines.—The New York *Electrical Engineer* says that Colonel Kimball, of the Quartermaster's Department in the Army Building, New York City, has received orders from the War Department to secure at once an iron ship of from 1,000 to 1,200 tons burden, to lay cables to connect the islands of the Philippines. The Department has already ordered for this purpose 166 miles of marine cable, weighing 525 tons. This cable will take about 6,500 cubic feet for coiling. The cable is to be coiled in skeleton tanks in different holds on the vessel. The cable ship must accommodate on the forward deck the "giving-out" machinery, which will weigh from 15 to 20 tons, and the accessories, weighing from 5 to 10 tons. In the after hold will be fitted out the quarters for the crew of 20 men. This space will be used for coal on the way out. The ship will be kept on station as a cable ship, or can, if necessary, be used as a transport.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—February 23rd. The Electric Committee wants tenders for water-tube boiler, two steam dynamos, and switchboard. See our "Official Notices" this week.

Buxton.—February 6th. The District Council wants tenders for feeders, mains, and arc light leads. See "Official Notices" January 20th for particulars.

Christiania.—February 26th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul-General at Christiania, stating that tenders are invited by the Norwegian State Telegraph Administration for the delivery of about 140,400 porcelain telegraph and telephone insulators. Tenders must be received at Christiania by 12 o'clock noon on February 26th, 1899. A copy of the specification, conditions, &c., may be examined on personal application at the Commercial Department of the Foreign Office any day, between the hours of 11 a.m. and 5 p.m.

Doncaster.—February 9th. The Guardians wants tenders for the installation of the electric light in their new workhouse buildings at Balby. See our "Official Notices."

Edinburgh.—February 20th. The Council wants tenders for overhead travelling crane and storage batteries. See our "Official Notices" this week.

France.—February 16th. The French Post and Telegraph authorities in Paris are inviting tenders for the supply of 46 kilometres of gutta-percha insulated electric cable. Particulars may be obtained from, and tenders to be sent to, Le Sous Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Glasgow.— February 6th. The Corporation wants tenders for the reconstruction of tramways in Crown Street and Cathcart Road. See our "Official Notices" January 27th.

Gloucester.—The City Council wants tenders for jet condensers, air pumps, cast-iron pipes, &c., for the electricity works. See our "Official Notices" this week.

Hull.—February 8th. The Corporation wants tenders for the electric wiring and fitting of the tramways power station, Osborne Street. The contract will include 4 arcs and 40 incandescents. See our "Official Notices" January 27th.

Italy.—February 25th. Tenders are being invited by the municipal authorities of San Severa (Province of Foggia), for the electric lighting of the town. Tenders are to be sent to Il Municipio di San Severa (Foggia), Italy, from whence particulars may be obtained.

Kingston-upon-Thames.—February 14th. Tenders are being invited for the provision of telephonic communication between the various buildings upon the workhouse premises, Kingston-on-Thames, for the Guardians. Particulars of the architect, Mr. W. H. Hope, Union Offices, Kingston.

Lowestoft.—February 6th. The Corporation wants tenders for the supply of boilers, steam dynamos and motor boosters, storage batteries, switchboard, travelling crane, mains, arc lamps and posts; and for the lighting of the station. Consulting engineer, Mr. W. C. C. Hawtayne. See our "Official Notices" January 6th.

Nelson (Lancs.).—February 14th. Tenders are being invited for the supply and erection of the following plant, for the Gas Committee:—(Section A) steam dynamo, ejector condensers, &c.; (B) switchboard; (C) alterations to accumulators; (D) overhead crane. Particulars to be obtained at the office of the engineer, Mr. Wm. Foster, Nelson, Lancs., on the deposit of £2 2s., which will be returned on the receipt of a *bonâ fide* tender.

Norway.—February 11th. Tenders are being invited by the Norwegian Telegraph Authorities in Christiania for the supply of 80½ tons of telegraph wire 4 mm. diameter and 121 tons ditto 5·3 mm. diameter. Tenders to be sent to the Bureau des Telegraphen, Director Karl Johansgade, 14, Christiania, whence particulars may be obtained.

Oystermouth.—February 27th. The District Council wants tenders for the supply of electricity within the area. See our "Official Notices" this week.

Southampton.—Tenders are invited for one 100-kw. engine and generator, one boiler, a set of accumulators, 20 motors, &c. See our "Official Notices" January 27th.

West Hartlepool.—February 13th. The Corporation wants tenders for feeders, mains, arc light leads, and road work. See our "Official Notices" January 27th.

Whitechapel.—February 7th. The Board of Works wants tenders for cables, arc lamps, steam dynamo, batteries, boilers and other machinery and apparatus for electricity works. See our "Official Notices" January 20th.

CLOSED.

Brighton.—The Lighting Committee recommends the acceptance of Messrs. Willans & Robinson's tender to supply and erect two combined engines and dynamos and condensing plant at the electricity works for the sum of £15,191.

London.—The London County Council on Tuesday received the undernoted tenders for the supply of dynamos, &c., required in connection with the proposed electric lighting of the Victoria Embankment:—

McClure & Whitfield	£3,726
Mather & Platt	4,600
Crompton & Company	4,949
Electric Construction Company	5,535
Safety Concentric Wiring Company	5,625
The Electrical Company	6,877

The following tenders were submitted for the supply of the gas engines required in connection with the same installation:—

J. E. H. Andrew & Company	£1,900
Campbell Gas Engine Company	2,176
Premier Gas Engine Company	2,260
Safety Concentric Wiring Company	2,260
Crossley Bros.	2,300
Fielding & Platt	2,378
J. Taylor & Sons	3,457

The Council referred the tenders to the Highways Committee for consideration and report.

London.—The Electricity Committee reported to the St. Pancras Vestry on Wednesday having received the following estimates for the supply of arc lamp columns required for the arc lighting of Regent's Park Road, Albany Street, and three other roads, the prices quoted being at per column:—

	Design A.	Design B.
W. Macfarlane & Co.	£9 14 0	£10 0 0
Falkirk Iron Company	10 0 0	
McDowell, Steven & Co.	9 9 0	9 2 6

The committee, who stated that Messrs. McDowell, Steven & Co. offered the quickest delivery, recommended that an order should be placed with that company for the supply of 50 columns according to Design B at £9 2s. 6d. each. This was agreed to.

FORTHCOMING EVENTS.

Monday, February 6th.—At 7.30 p.m. Society of Engineers. Presentation of premiums by the retiring president (Mr. W. Worby Beaumont). Presidential address by Mr. J. Corry Fell.

Tuesday, February 7th.—At 8 p.m., at 11, Chandos Street, Cavendish Square, W. Röntgen Society. Paper by Mr. Wilson Noble on "A Modified Form of Toepler Mercury Pump." Discussion on the Röntgen ray photography of soft tissues, introduced by the president, Dr. Mansell-Moullin.

Wednesday, February 8th.—At 8 p.m. Society of Arts. "Nernst's Electric Lamp," by James Swinburne. Mr. Alexander Siemens will preside.

Thursday, February 9th.—At 8 p.m. The Institution of Electrical Engineers, continuation of discussion on "Rules for the Regulation of the Wiring of Premises for connection to Public Supply Mains," by J. Pigg, associate; "The Regulation of Wiring Rules," by C. H. Wordingham, member; "The Institution Wiring Rules," by R. E. Crompton, past-president. If time permits, "Electric Traction by Surface Contacts," by Miles Walker, associate.

Friday, February 10th.—At 5 p.m. Physical Society. Annual General Meeting: address by the president. After which at an ordinary meeting, "An Amperemeter and a Voltmeter with a Long Scale," by Benjamin Davies, probably to be read by Dr. Lodge.

At 8 p.m.—Institution of Civil Engineers, Students' Meeting, paper on "The Electrical Driving of Engineering Workshops," by William Middleton, Stud.I.C.E.

At 7.30 p.m.—At the Westminster Palace Hotel. The Institution of Junior Engineers, joint meeting with the Discussion Section of the Architectural Association. Paper on "Factory Design," by Mr. J. H. Pearson, M.I.J.E.

Saturday, February 11th.—At 2.30 p.m. Visit of Institution of Electrical Engineers (Students') to the Shoreditch Central Station, Coronet Street, Shoreditch. Party limited to 20.

Saturday, February 18th.—At 3.15 p.m. Institute of Junior Engineers' visit to the Ealing Electric Lighting and Destructor Works.

NOTES.

Institution of Junior Engineers.—On Friday, March 3rd, a paper on the "Direct Production of Electricity from Carbon," will be read by Mr. W. R. Cooper, A.I.E.E. The conversazione will be held on March 11th.

Presentation.—On 20th ult. Mr. R. Liddell, was presented by the staff of the Edinburgh Electricity Department with a gold albert chain, with pendant, on the occasion of his departure to take up a position in the Leith Electricity Department.

Appointment Vacant.—The King's Lynn Corporation wants an electrical engineer to take charge of the new electricity works. See our "Official Notices."

The Royal Society.—Among the papers down for reading yesterday afternoon were:—Prof. A. Schuster, F.R.S., and G. Helmsalech, on "The Constitution of the Electric Spark." Dr. Magnus Maclean, "On the Effects of Strain on the Thermo-Electric Qualities of Metals."

Society of Arts.—In the calendar of meetings arranged for February and March are the following:—February 8th, 8 p.m., Mr. James Swinburne, "Nernst's Electric Lamp." February 22nd, 8 p.m., Mr. Philip Dawson, "Electric Traction, and its Application to Railway Work." March 15th, 8 p.m., Sir Marcus Samuel, "Liquid Fuel."

Owens College.—A donation of £2,000 has been received from Captain Partington towards the cost of building the new physical laboratory at Owens College, and Dr. E. Hopkinson has sent a sum of £1,884, contributed by the relatives of the late Dr. John Hopkinson for the erection of a wing of the laboratory to be devoted to electro-technical work.

Municipal Trading.—In the course of the discussion at the Society of Arts on Wednesday on Mr. D. H. Davies' paper on "The Cost of Municipal Enterprise," Sir Richard Webster, who presided, said that there was a great deal of cant in the talk about monopolies, but there was no greater monopoly, he thought, than in giving municipalities the sole right to supply electricity.

Order for Electric Locomotives.—We hear that Messrs. Crompton & Co., Limited, have secured an order from the City and South London Electric Railway Company, for 10 electrical locomotives, each to cost £1,350.

X Rays.—It is stated that Mr. James Mackenzie Davidson, M.B., C.M., has been appointed honorary medical officer in charge of the X Ray Department, Royal London Ophthalmic Hospital, Moorfields.

The Electrical Standardising, Testing, and Training Institution.—As a result of the recent scholarship examinations the board of control of this institution have made the following awards:—To Mr. Gerald Adamson Hopkins a Maxwell Scholarship of 50 guineas, tenable for two years; to Mr. Thomas Gregory Smith, of Blackheath School, an exhibition of 30 guineas, tenable for two years; and to Mr. Leonard Roseveare, of Dunheved College, Launceston, a prize of 20 guineas.

City and Guilds of London Institute.—The annual prize distribution was held last week at the Leathersellers' Hall, E.C. Mr. Alderman and Sheriff Alliston occupied the chair. The hon. secretary (Mr. John Watney) submitted the report, which stated that the diplomas, certificates, medals, and prizes to be presented on that occasion, numbering about 230, were awarded last year to students of the Central Technical College, the Technical College, Finsbury, the South London Technical Art School, and the Leather Trades School. Mr. Preece, after handing the awards of the successful students, stated that the prize fund was now supported by 22 of the Livery Companies. The mode of testing the technical education of the country by means of examinations held in different centres, was inaugurated by the Society of Arts, but it was soon taken up very warmly by the City Guilds. When the examinations were started in 1879, there were only 23 centres and 151 passes, while last year the centres numbered 369, and the passes 7,953. He advocated the more general teaching of science in schools, and spoke of the valuable educational work that was being done by the London polytechnics.

Teaching Electro-Chemistry.—*Apropos* of our article last week on "The Provision for Teaching Electro-Chemistry in this Country and Abroad," our attention is directed to the fact that we omitted to mention the systematic courses in electro-chemistry which are given at the Northampton Institute, Clerkenwell. During the present session there are courses of instruction in electroplating and electrotyping, the department being in charge of Mr. S. Field as lecturer and demonstrator. The equipment for the teaching of this work is not quite completed but is very far advanced. When a sufficient demand arises, the Institute authorities are prepared to extend the equipment for this particular work very largely.

Personal.—Early this month Mr. E. O. Walker, who has relinquished the position of superintendent of telegraphs to the Ceylon Government, left Colombo on his return to Europe. On the way home he will stay for a fortnight in Egypt, visiting Cairo and the Pyramids.

Mr. A. G. Bird, station superintendent, writes from Bristol electricity works regarding the notice last week under "Appointments," in which he is described as being previously on the staff of the Yorksire House-to-House Electrical Company. "As this has been the cause of some misunderstanding and correspondence," says Mr. Bird, "I shall be glad if you will kindly make a correction in your next issue. It should be:—Mr. A. G. Bird, formerly of the Cardiff Corporation electric lighting station, and the Morley Corporation electric lighting station."

The Institution of Junior Engineers.—The fourteenth anniversary dinner of this Institution took place on Saturday evening last at the Westminster Palace Hotel, under the presidency of Sir W. H. White, F.R.S., Director of Naval Construction and President-Elect of the Mechanical Engineers. After the usual loyal toasts, Prof. Spooner proposed "Our First Line of Defence," which was acknowledged by Sir John Durston, K.C.B., Engineer-in-Chief of the Navy. Then came "The Anglo-Saxon Race," proposed in felicitous and eloquent terms by Mr. J. Macfarlane Gray, but from the moment of the reply by Lieut. Colwell, U.S.A., Naval Attaché, American Embassy, there was little else than the glorification of Britishers and Yankees, and exultation at the passing of the Latin races for evermore. The Anglo-Saxon race dominated the world; supremacy in engineering made the race what it has become, therefore the whole world was made up of engineering. It was openly stated that England could make further conquest in South Africa, while the United States could easily annex portions of South America, both to the advantage of the Anglo-Saxon race. Prof. Ayrton, in a speech which for him was unusually sombre and caustic in character, proposed the toast of "The Senior Institutions," and we can only infer that much of what he said was in the nature of a protest that it should be thought we lived only for engineering, or that the Latin races should have been spoken of with such cordial detestation as seemed to animate the speakers on this occasion. "The Institution of Junior Engineers" was toasted on the motion of Mr. Charles J. Owens, general manager of the London and South-Western Railway, and Mr. Basil H. Joy, chairman, in reply, stated that the progress of the Institution, numerically and financially, was so satisfactory, that there was a reasonable prospect of their being able ere long to set up in a home of their own. Other toasts followed, amongst them an unofficial one to Mr. W. T. Dunn, the amiable and energetic secretary, who has done so much towards putting the Institution of Junior Engineers on such a firm footing, and the enthusiasm with which his name was received betokened the sincere esteem and affection felt for him by his colleagues. Instrumental music and songs helped to enliven the proceedings, and the meeting did not disperse till a comparatively late hour.

Mr. Preece on English Electrical Contractors.—The 12th annual dinner of the Manchester Association of Students connected with the Institution of Civil Engineers was held on 25th ult. in the Albion Hotel, Manchester, and was attended by a large number of members and friends. The chair was occupied by Mr. W. B. Worthington, the president of the Manchester Association of Students. Replying to the toast of "The Institution of Civil Engineers," Mr. W. H. Preece, C.B., spoke of the apathy that prevailed among merchants in one part of the community. He had only on the previous day received a letter from his brother, who, as a Consul in Persia, was brought into direct contact with commerce and trade. He wrote that our merchants did not seem to care to stir a hand to lift our British trade in Persia. He (the speaker) was a member of the Royal Commission dealing with the coming French Exhibition, and they were most anxious to secure for that Exhibition a goodly display of electrical apparatus. They secured a contract by which the French Administration were prepared to pay a portion of the expenses. The contract was offered to all our manufacturers who were in a position to comply with it, but there was not one single English firm who came forward prepared to supply apparatus required to supply light to the Exhibition. The engineers came forward like men, but they were not supported by the electrical industry, and the result would be that there would be a miserable and poor display of electrical apparatus at the great Exhibition. With regard to the complaints sometimes made that we were suffering from a lack of technical education, he did not agree with that. Technical education in this country during the last 10 years had advanced with giant strides, and he believed at the present moment we were as well advanced as anybody.

CITY NOTES.

City and South London Railway Company.

The twenty-ninth ordinary general meeting of the shareholders of the City and South London Railway Company was held on Tuesday last at Winchester House, Old Broad Street, Mr. C. G. Mott in the chair.

The Chairman, in moving the adoption of the report, said it was very pleasing to the directors to be able to report of the past half-year, as they had of previous years, a steady and uninterrupted progress in the dividend-earning power of the line. They were able to recommend the shareholders to declare an increased dividend of ¼ per cent., making 2 per cent. for the past half-year, which with the dividend declared last midsummer makes a rate of 2¼ per cent. for the whole of last year. Although that dividend was not a very large one, it was steadily improving, and they looked forward to the time, not very far distant, when they hoped it would be considerably larger. But if they recollected that the cost of the line before they incurred any expenditure in connection with the extensions which were now going on was a little over £800,000, and that the net earnings for last year were over £24,000, they would see that they were earning now on the whole cost of the line about 3 per cent. per annum. Of course the debentures and preference stock absorbed more than that 3 per cent., and therefore up to the present the ordinary capital had only received 2¼ per cent., but when a line in these days was earning 3 per cent. on its actual cost, with a steadily growing traffic and improved dividends, he thought he might fairly say that it had proved itself a financial success, and was sufficient to justify the expenditure of additional capital in regard to other electric lines throughout the metropolis. It was a very important thing for London to have shown that capital invested in a concern like this could return in the comparatively early stages of its existence 3 per cent. on its outlay. That fact must lead in the future to the provision of additional lines for the accomodation of traffic in London, which were so imperatively needed. They had done that much for the public benefit, and he hoped the time would come when they would feel that they had not invested their money foolishly in the line, but that they would receive a return which would satisfy the shareholders. During the past half-year they had been making very satisfactory progress with the extensions. The whole of the underground works of the extensions from the City were practically complete. It now remained for them to complete the lifts and surface stations, and various other small matters before the line would be fit for opening; but they hoped by the time of the next half-yearly meeting they would be able to announce either that the line was already opened for traffic, or else to tell them on what date it would be opened. The Clapham extension had gone on with great rapidity. They had a very energetic contractor, and he had made very rapid progress—much more rapid, in fact, than they anticipated, and they were in great hopes that that line might be opened almost simultaneously with the opening of the extension from the City. He thought they would agree with him that that was very satisfactory progress in difficult work of that kind. During the past half-year the traffic had steadily increased.

The number of passengers carried showed an increase of 124,953, and they had increased receipts from those passengers of £825, which, with an increase of £22 from season tickets, made a total increase of £847 for the half-year. The subway between their line and the Central London Railway at the Bank was now complete, and he was in hopes that that line would have been opened very shortly; but he saw by the newspapers that there was likely to be some further delay, although it could not be very long before the line would be in working order. He thought they might assume that there would be a very large exchange traffic between their railway and that of the Central London at that point. There was another subway in contemplation, and that was one under the Brighton Company's station at London Bridge to connect with their line. That had not yet been commenced, but they were in active negotiation with the Brighton Company on the point, and he hoped that before long they would be able to come to some definite and satisfactory arrangement as to the construction of that subway. There was another electric line going to be made, called the Great Northern and City Railway. He believed they were now proceeding actively with the construction of that line, and its terminus would adjoin their present terminus at the Moorgate Street station in Finsbury Pavement. They hoped they would be able to arrange with that railway also for a subway to connect the two platforms. There was also another line called the Walthamstow and Epping Forest Railway, which would have its terminus almost at the same place, and so, with their connection with the Metropolitan Railway at Moorgate Street, and also with those two other lines, they hoped to get a very large exchange traffic there. They were providing increased power at their Stockwell depôt to work those extensions. The works were all making very rapid progress, and the things required for working the extensions were all contracted for—including new engines and new rolling stock. The extension through the City was a very important piece of line, for it ran through the heart of the biggest city in the world, and its stations were in the very best possible position for the traffic. It had undoubtedly cost them a great deal more per mile than the other portions of the line, but that was only to be expected. It was, however, a piece of line the value of which could hardly be over estimated, and it was necessary in the interests of the company that they should make the utmost possible use of it. They had got the line extended on the south to Clapham, and they now wanted to bring on to that City line the heavy traffic coming from the north of London. Anyone who knew the neighbourhood of Islington, knew that it was about one of the busiest centres of the metropolis, and they felt perfectly certain that they could bring in a large amount of traffic from that source. They therefore proposed to take the earliest opportunity they could of completing the line up to the Angel at Islington, and they would then have a very big traffic into the City, both from the north and south of London. The cost of the line from the Angel would be much less per mile than the line from the City, and they would be able to work it from their present generating station at a moderate cost. The length was barely a mile and a half, and he thought they would get highly satisfactory results from the extension. There was one other line he wished to refer to and that was the City and Brixton. It was essential in these underground railways, if they were to be a success—first, the capital should be kept down within moderate limits; and, secondly, that they should be worked with the utmost possible economy. The capital of the City and Brixton Railway was a very moderate one, and he believed that they would be able to work the line very economically. Turning to the accounts, the chairman said that during the half-year they had received on capital account, in shares £71,000, in debenture stock £20,000, and in premiums £13,000, making a total of £104,000. They had expended during the same period £157,000—£53,000 more than they received. As regarded the revenue, passengers, as he had already told them, showed increased receipts of £847, parcels an increase of £26, rents an increase of £238. On the other hand, there was a decrease of £28 in transfer fees, and of £24 in sundry receipts, which left a net increase of £1,059. In the half-year they had had to increase their expenditure to some extent, and the maintenance had been increased by £214, carriage repairs by £92, traffic expenses by £180, general charges £98, and law charges £1. Altogether there was an increased expenditure of £462, which deducted from £1,059 increased receipts, gave them a net decreased expenditure of £997. The number of trains run had been increased from 73,142 to 74,339. The number of passengers per train had increased from 45·64 to 46·58. That was a very satisfactory and growing average which was a very important element in the question of profit. The receipts per mile had increased from 7s. 3·04d. to 7s. 3·06d., and per train mile from 2s. 3·63d. to 2s. 4·28d. The receipts per passenger remained about the same. The working expenses had decreased from 56·68d. to 56·18d. That was extremely satisfactory, seeing that nowadays the tendency was for working expenses in connection with railways to increase. Locomotive and generating charges had been reduced from 5·83d. to 5·65d.

Mr. Sampson Hanbury seconded the motion, which, after some discussion, was carried.

Direct United States Cable Company.

Mr. E. M. Underdown presided on Tuesday, at Winchester House, over the forty-third ordinary general meeting. In moving the adoption of the report, he said the revenue for the six months ending December last, after deducting out payments, amounted to £54,366 4s. 10d., as compared with £50,098 2s. 8d. for the corresponding period of 1897. The working and other expenses, including income-tax, absorbed £21,621, and there was then a net profit of £32,745. With the sum of £3,388 brought forward there was a total of £36,133 available for distribution, and this had been distributed as follows:—Interim dividend of 3s. per share to September 30th, £9,106; further interim dividend to December 31st of 3s. per share, £9,106; set aside for reserve, £12,000; and carried forward, £5,920. The revenue had increased by £4,268, or more than 8 per cent. as compared with the corresponding period of 1897, but he must say that a portion of this increase had to be attributed to exceptional causes. There was, however, every sign that communication between the United States and the rest of the world was not likely in the future to diminish. During the current year the traffic, so far as they had gone, had been satisfactory, and of course the increased business had led to some addition in the expenditure, but after making allowance for special outlay under the head of maintenance due to necessary improved landline transmitters and cable duplex apparatus, and extra expense of repairs to buildings, it would be seen that the expenditure had been kept at a very reasonable figure. Fortunately they had no cable repairs to effect during the half-year. The reserve fund had been increased by £5,859 from interest, £768 from revenue on securities sold, and by £12,000 from revenue, making a balance of £368,534. Proceeding, the chairman said he had received a letter from a shareholder respecting the question of amalgamation dealt with at a recent meeting of the Anglo-American Company, but that was a matter he could not deal with at a public meeting. It would be clear, however, that practically they had amalgamation with their allies in the existing pool arrangement. There was, however, a great feeling against gigantic monopolies, and it was desirable that there should be something like independence on the part of the Western Union Company, the Anglo-American Company, and their own company.

Sir James Pender, Bart., M.P., seconded the adoption of the report, which was carried.

Mr. Hancock thought that in time the question of the alliance with some of the other companies must come. The Direct United States Cable Company in only having one cable was in a very weak position, although it had proved itself capable during the present year.

A Shareholder thought that if they amalgamated it would prove a source of weakness. All previous arrangements have been in the interests of individuals with large holdings, and he thought that the directors should not contemplate such a step without a very large majority of the shareholders approving of it.

The Chairman said he could assure them that this question was always before them. They could rest quite content with the participation they had got, and the shareholders would be looked after as far as they were concerned. The cost of replacing the cable was considerably enhanced, as the cost of the material was higher in price. They must look after the reserve fund and keep the company in equality with the others. He then moved that an interim dividend of 3s. per share be paid, which was carried.

A vote of thanks to the chairman and directors closed the meeting.

Amazon Telegraph Company, Limited.

The fourth ordinary general meeting was held last Friday at the offices, Blomfield House, London Wall. Mr. W. S. Andrews presided, and, in moving the adoption of the report, stated that they were not meeting on that occasion as soon as they could have wished, but this was owing to the difficulties they had had to contend with, and the necessity of making some sort of financial arrangements—or of seeing their way to make them—before calling the shareholders together. Their receipts were not so discouraging as they might have been, because, notwithstanding interruptions in the main revenue-producing section of the system, they had amounted to £29,446, or £4,148 more than they were for the previous year, which was also an interrupted period, although, perhaps, it was not so badly interrupted as the past year had been. The working expenses had been £18,494, as compared with £20,164. They had therefore had a reduction in their expenses combined with an increase in their receipts. But, of course, although these figures were in the right direction, they were eminently unsatisfactory as a whole, and they showed that the company's enterprise, from circumstances which the shareholders were aware of, had not been for any length of time in a proper revenue-earning condition. They had had, besides, an unusually heavy flood season, which had impeded their operations and caused unexpected difficulties. In fact, owing to the constant interruptions, there had been no possibility of developing the traffic. That the trade was there there was no doubt, and with the lines working properly the undertaking would certainly prove its remunerative character. Their difficulty was one only. Everything promised well for the concern if they could only keep their lines permanently at work, and this was what the directors had been doing their utmost to accomplish. They had at last apparently confined their difficulties to certain localities only; these they had now alone left to conquer, and if they could do this their prospects would be very hopeful. They had taken measures to circumvent, so to say, dangerous parts of the main stream, and had sent out aerial insulated wire cable to bridge over by land impossible spots, and they were sending out more, as well as arranging surveys in places for the substitution of overground wires for the submerged cable. They thought they might require all these things at different places owing to varied troubles they had had to contend with, and they believed that by these means they might be able to succeed. They could not, however, prophesy, but they believed that they were on the right track to overcome the difficulties in the main stream should they prove to be insurmountable here and there, or at all events insurmountable unless at prohibitive cost. They believed that the authorities recognised the hard struggle the company had had, and were having, and that they sympathised with the company's continued efforts. All that the authorities wanted was the telegraphic communication, and

if the company could give them this they would be satisfied. They intended to do their utmost to succeed, and they hoped eventually to do so. Meanwhile, they were doing all that they could to reduce expenses. The directors were taking no fees, leaving these to be paid when the prosperity of the company should provide for this. The only exception to this arrangement was that of Mr. Keith, who had been giving special attention and so much time to the company's affairs that it was felt that it would be unfair to ask him to submit to this sacrifice while they continued to make such demands upon his time and energies.

Mr. George Keith seconded the motion.

In reply to questions, the Chairman stated that the original capital of the shareholders was certainly not swallowed up, inasmuch as there was a large length of cable working in the Amazon to represent it. They were, moreover, earning a revenue which more than paid their expenses. If they were successful in their efforts to establish the communication and to maintain it they had no doubt whatever that the revenues would be most satisfactory. All that they had to do was to keep the communication open, and if they could do this the public and trade and commerce would do the rest for them. The question of wireless telegraphy had been under their consideration in connection with their difficulties.

The motion was carried unanimously.

An extraordinary general meeting was held afterwards, when a resolution was submitted authorising the directors, from time to time, to create and issue, on such terms and in such manner as they might determine, debentures for an amount not exceeding in the whole £75,000, such debentures to rank *pari passu* with the existing issue of £125,000, and to be entitled to the benefit of the trust deed of August 1st, 1897.

The Chairman, in answer to a question, stated that the security for the debentures consisted of the lines and the company's concessions.

The resolution was carried unanimously.

Anglo-American Telegraph Company, Limited.

The report of the directors, to be presented to the ordinary general meeting of the proprietors, to be held at Winchester House, 50, Old Broad Street, London, on Friday, February 3rd, 1899, at 2 o'clock p.m., states that the total receipts from July 1st to December 31st, 1898, including the balance of £17,580 6s. 2d. brought forward from the last account, amounted to £212,493 2s. 1d. The traffic receipts show an increase of £14,418 as compared with the half-year ended December 31st, 1897. The total expenses of the half-year, including the repair of cables, &c., as shown by the revenue account, amounted to £63,404 18s. 6d., being an increase of £5,032 14s. 1d. over the corresponding period of 1897. The directors, under the powers conferred upon them by the articles of association, have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £137,088 3s. 7d. Interim quarterly dividends of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, were paid on November 1st last, absorbing £52,500, leaving a balance of £84,588 3s. 7d., out of which the directors recommend the proprietors to declare final dividends of £1 4s. per cent. on the ordinary stock, £1 10s. per cent. on the preferred stock, and 18s. per cent. on the deferred stock, amounting to £84,000, making a total distribution for the year ended December 31st, 1898, of £3 9s. per cent. on the ordinary stock, £6 per cent. on the preferred stock, and 18s. per cent. on the deferred stock. The balance of £588 3s. 7d. will be carried forward to the next account. In accordance with the articles of association, two directors of the company, Mr. F. A. Bevan and Mr. W. S. Cunard, retire at this meeting, and, being eligible, offer themselves for re-election. Mr. Joshua Dean and Mr. John Gane, F.C.A., the auditors, retire, and offer themselves for re-election.

The St. James's and Pall Mall Electric Light Company, Limited.

The report of the directors and statement of accounts for the year ending December 31st, 1898, to be submitted at the ordinary meeting of the company next Tuesday, at the offices of the company, states that the directors submit their report for 1898, with the accounts as certified by the company's auditors. The Carnaby Street and Mason's Yard stations have been working satisfactorily throughout the year, but to enable the company to meet the growing demand for electrical energy in the most efficient manner, it has become necessary to further extend the Carnaby Street station. For this purpose the directors are promoting a Bill in the ensuing session of Parliament authorising the company to acquire by compulsory purchase certain adjacent property. To meet future requirements the directors have by agreement arranged with the Westminster Electric Supply Corporation, Limited, for the promotion in the ensuing session of Parliament, under the title of the Central Electric Supply Company, Limited, of a Bill authorising the establishment of a station on certain property to be acquired in the parish of St. Marylebone. This will secure to the two companies an ample supply of electrical energy in bulk. In pursuance of special resolutions passed at extraordinary general meetings held on January 18th and February 8th, 1898, 20,000 new ordinary shares of £5 each were created, making the capital £300,000, and 12,000 of these shares were issued at par to the holders of the 100 founders' shares of £1 each. These founders' shares are now vested in a trustee for the company. The company has since by special resolutions passed at extraordinary general meetings held on January 3rd and 19th increased the capital to £300,100 by the creation of 20 new ordinary shares of £5 each. Steps are now being taken to reduce the capital of the company by cancelling the 100 founders' shares, and a notice for an extraordinary general meeting to be held at the conclusion of the ordinary meeting confirming this reduction is sent out with this report. So soon as further capital is required, the directors propose to issue the balance of 8,020 ordinary shares to the shareholders in proportion (as nearly as conveniently may be) to the shares held by them, at a premium. This will enable a substantial addition to be made to the reserve fund. In accordance with the terms of the trust deed, six months' notice of redemption was given to the holders of the £50,000 4 per cent. debenture stock of the company, and this stock is now being paid off as on January 1st last. The net earnings of the company during the past year have amounted to £29,889 19s. 1d. Of this sum £11,495 was distributed in August last in payment of an interim dividend at the rate of 10 per cent. per annum for the half-year ending June 30th, 1898, on the ordinary shares, and at the rate of 7 per cent. per annum on the preference shares. The balance, £18,394 19s. 1d., together with the undivided profit of £384 10s. from last year's account, leaves £18,779 9s. 1d. now to be dealt with. The directors propose to divide the amount as follows:—

	£	s.	d.
(*a*) By payment of a dividend at the rate of 7 per cent. per annum on the preference shares for the second half of the year	3,500	0	0
(*b*) By payment of a dividend on the ordinary shares for the second half-year of 7s. 6d. per share, and a bonus of 2s. per share, making, with the interim dividend paid on August 1st last, a total distribution of 14½ per cent. for the year.	15,190	10	0
(*d*) Amount to be carried forward	88	19	1
	£18,779	9	1

The directors deeply regret the loss by death of their esteemed colleague, Mr. Latimer Clark, F.R.S., the vice-chairman of the company. Mr. Marlborough R. Pryor has been elected a director during the year, and in accordance with the articles of association he now retires, but, being eligible, offers himself for re-election. Mr. Walter Leaf retires by rotation under clause 79 of the articles of association, and being eligible, offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and, being eligible, offer themselves for re-election.

The Liverpool Overhead Railway Company.

The report of the board of directors to be presented to the twenty-first ordinary half-yearly general meeting of the shareholders, to be held at the Law Association Rooms, 14, Cook Street, Liverpool, on Tuesday, February 14th, 1899, states that, in presenting the half-yearly statement of capital and revenue accounts to December 31st, 1898, the directors have to report that the gross revenue receipts amount to £40,840 3s. 2d., and the working expenses to £24,717 15s. 4d. The number of passengers carried during the last two years is as follows:—

	Half-year ending June 30th, 1897.	Half-year ending Dec. 31st, 1897.	Half-year ending June 30th, 1898.	Half-year ending Dec. 31st, 1898.
First class... ...	608,278	621,392	637,547	663,177
Second class ...	2,618,844	2,790,768	2,686,651	2,962,827
Workmen (special return tickets)...	1,042,138	1,055,330	1,148,743	1,268,917
Total ...	4,269,260	4,467,490	4,472,941	4,894,921

Revenue Account.

Receipts from passenger traffic amount to ...	£40,071	10	4
Miscellaneous receipts and interest	768	12	10
	£40,840	3	2
Less working expenses	24,717	15	4
	£16,122	7	10
Deduct interest on mortgage debentures ...	3,400	0	0
	£12,722	7	10
Add balance brought forward, June 30th, 1898...	3,863	13	7
Leaving available for dividend	£16,586	1	5

Out of this balance the directors recommend the declaration of dividends at the following rates (less income-tax), payable on and after February 16th next:—

5 per cent. per annum on preference shares ... £3,000
4 „ „ on ordinary shares ... £9,000

leaving a balance of £4,586 1s. 5d. to be carried forward to next half-year. The directors have arrived at a basis of agreement with the Waterloo-with-Seaforth and Great Crosby District Councils (subject to the sanction of the shareholders and confirmation by Parliament) for the company to equip and work the tramways already authorised within those districts. The directors retiring by rotation at this meeting are Sir Wm. B. Forwood and Mr. H. Brocklebank, who, being eligible, offer themselves for re-election. The auditor retiring by rotation is Mr. J. S. Harmood Banner, who is also eligible for re-election.

Waterloo and City Railway Company.

The report for the half-year ended December 31st states that the railway was opened for traffic on August 8th, since which date the train services have been carried on by the London and South-Western Company, in accordance with the agreement of March 8th, 1894. The City terminus subways and connecting approaches are being proceeded with by the Central London Railway Company, and will, it is hoped, be completed by the end of the current year. The capital account shows a total outlay of £549,456, and the further estimated expenditure of £52,000 is amply provided for by the capital powers of the company. The gross receipts amounted to £10 887. From this amount the London and South-Western Company have retained £4,119 in respect of working expenses, leaving the sum of £6,768 payable by them in order to provide, under the agreement of March, 1894, for a dividend at the rate of 3 per cent. per annum from August 8th to December 31st, 1898, on the company's ordinary and borrowed capital. To this sum has been added bankers' and general interest, and a portion of the profit on the sale of consols representing the Parliamentary deposit, which enables the directors to recommend the payment of a dividend at the rate of 3 per cent. per annum for the full half-year.

Automatic Telephone Company.

There were some very lively proceedings at the adjourned ordinary general meeting of the above company, held on Wednesday morning at Winchester House. Before the notice convening the meeting had been read Mr. Parker said that he was going to impugn the conduct of the chairman in connection with his dealings with the company, and he proposed that Mr. Barlow take the chair.

Mr. Margowski (managing director) by whom the notice calling the meeting was signed, declared this out of order, and amidst a hostile demonstration, refused to leave the chair. Mr. Margowski then proceeded to make some remarks, which were quite inaudible, in consequence of the uproar made by the shareholders; but he concluded by moving that the report and accounts be adopted. [No copy of report was available.]

Mr. Cohen seconded the motion, which the Chairman declared carried, although only two voted for it.

The meeting at this stage had developed into an absolute farce, the Chairman proceeding to declare that a poll had resulted in an immense majority for the motion (although no one in the room was invited to record his poll), and also that resolutions to remove Mr. Alexander from the board, and for the appointment of auditors, had been carried, although neither was properly put to the meeting.

During these proceedings several shareholders suggested the forcible removal of the chairman, and once Mr. Alexander made an attempt to do this, but was prevailed on to desist.

Finally the Chairman declared the meeting closed, and left the room amidst the ironical cheers of the shareholders.

The meeting then voted Mr. Barlow to the chair, and this gentleman said that Mr. Margowski had defended an action brought against the company by the managing director without any consultation with the board, but he presumed the company would have to pay the costs.

Mr. J. D. Gibbs (one of the directors) read a letter from the engineer, Mr. Seligman Lui, who stated that he had been misled by Mr. Margowski. He (Mr. Gibbs) said he did not think that Mr. Margowski was a proper person to conduct the company, and that if he retired the company would go well.

Mr. Barker said they had not treated Mr. Margowski fairly, as Mr. Margowski had offered to retire from the chairmanship after the meeting, and to pay into the bank the balance of £5,000.

Mr. Barlow said that Mr. Margowski had stated that Mr. Lui was bound by agreement to the company, but that was not the case. Then he took credit for getting various patents transferred to the company, but as a matter of fact, except one all the patents had been taken out by the company.

Mr. Parker gave particulars of an interview he had with Mr. Margowski after the last meeting. It was true that Mr. Margowski had offered to retire from the chairmanship, but it was only on the understanding that the new board should consist of his own nominees.

Mr. Barlow said he had discussed with Mr. Lui the value of his invention, and Mr. Lui refused to go on with the matter in the present position of the company. Mr. Lui, however, had absolute confidence that his invention was perfect, and he put it to them what an advantage it would be if a person could turn a handle and speak to anyone.

Replying to a shareholder, Mr. Parker said the question as to whether that meeting was a legal one would have to be fought out in another place.

Mr. Parker next moved resolutions that the report be not approved, that the chairman be removed, that a committee of shareholders be appointed, that auditors be appointed to make a proper statement of the affairs of the company, and that the meeting be adjourned until after the action brought by Mr. Alexander and Mr. Gibbs against the company was decided.

After further discussion this resolution was carried.

South Staffordshire Tramways Company.—An extraordinary meeting of this company will be held at the Cannon Street Hotel on Wednesday, February 8th, for the purpose of considering the provisions of the Bill now before Parliament, intituled "A Bill for Conferring Further Powers upon the South Staffordshire Tramways Company with respect to the Leasing and Working of Tramways and for other Purposes."

National Telephone Company.—The directors have resolved, subject to final audit, to recommend at the forthcoming general meeting of shareholders the following dividends for the half-year ending December 31st last:—At the rate of 6 per cent. per annum, less income-tax, on the first and second preference shares. At the rate of 5 per cent. per annum, less income-tax, on the third preference shares. At the rate of 6 per cent. per annum, free of income-tax, on the ordinary shares, carrying £50,000 to reserve, and about £8,000 forward. The transfer books will be closed from February 4th to 17th, both days inclusive, and the dividend warrants will be posted on the latter date.

Great Northern and City Railway Company.—The first report states that the whole of the share capital was offered for public subscription in July last. The 78,000 preferred class A shares, amounting in the aggregate to £780,000, and 26,733 deferred class B shares, amounting in the aggregate to £267,330, were applied for and allotted. The Board of Trade have given the necessary certificate for payment of interest out of capital on both classes of shares in accordance with the company's Act of 1892. The contractors are proceeding as rapidly as possible with the construction of the line.

The County of London and Brush Provincial Electric Lighting Company, Limited.—There has been offered during the week a first issue of £200,000 4½ debenture stock at the price of £108 per cent, forming part of the authorised issue of £400,000, redeemable on six months' notice at the company's option in 1923, at the rate of 115 per cent. The company is conducting a business which is not yet obtaining the full benefit of the plant erected; the gross profits for 1898 are estimated at £25,000, against £11,681 for 1897.

The Charing Cross and Strand Electricity Supply Corporation, Limited.—The directors, after providing £7,000 for depreciation, carrying forward £3,500, have decided, subject to audit, to recommend a dividend for the half-year ended December 31st, 1898, at the rate of 10 per cent. per annum, (making, with the interim dividend distributed for the half-year ended June 30th, 1898, at the rate of 6 per cent. per annum,) a dividend payable for the year 1898 of 8 per cent. on the ordinary share capital.

Yorkshire House-to-House Electricity Company.—An extraordinary general meeting of the company to confirm the resolution to voluntarily wind up the company is to be held on Friday, February 10th. Resolutions appointing Mr. Grosvenor Talbot, the present chairman of the company, as liquidator, and Mr. John Gordon, as auditor to supervise the accounts, will be proposed.

Stock Exchange Notices.—Application has been made to the Stock Exchange Committee to allow to be quoted in the Official List:—New General Traction Company, Limited—10,000 vendors' 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 10,000.

Westminster Electric Supply Corporation, Limited.—The directors recommend a dividend for the past half-year at the rate of 14 per cent., making with the interim dividend 12 per cent. for the year 1898.

Globe Telegraph and Trust.—The directors announce a quarterly interim dividend at 1s. 9d. per share.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending January 28th, 1899, were £154 14s. 11d.; aggregate to date, £564 17s. 1d.

The Bradford City Tramways.—The receipts for week ending January 29th, 1899, were £247 11s. 1d.; total receipts to date, £6,485 5s. 2d.; miles of track open, 4·72; number of cars, 16.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending January 27th, 1899, were £2,382 9s. 1d.; corresponding period, 1898, £2,344 7s. 11d.; increase, £88 1s. 2d.

The City and South London Railway Company.—The receipts for the week ending January 29th, 1899, were £1,134; week ending January 30th, 1898 £1,059; increase, £75; total receipts for half-year, 1899, £5,553; corresponding period, 1898, £5,393; increase, £160. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending January 28th, 1899, were £132 5s. 2d.: week ending January 29th, 1898, £103 7s. 7d.; increase, £28 17s. 7d. Total receipts to date, 1899, £586 19s. 1d.; corresponding period, 1898, £437 0s. 3d.; increase, £149 18s. 10d. Miles of track open week ending January 28th, 1899, 3; week ending January 29th, 1898, 3. Car miles run week ending January 28th, 1899, 4,297; week ending January 29th, 1898, 2,696. Number of cars, week ending January 28th, 1899, 11; week ending January 29th, 1898, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, January 27th, 1899, were as follows:—D. U. T. Co., horse cars, £1,830 9s. 6d.; ditto, electric cars, £730 5s. 10d.; D. S. D. Co., electric cars £604 8s. 8d.; total, £3,165 4s.; corresponding week last year—D. U. T. Co., horse cars, £2,607 11s.; ditto, electric cars, £123 19s. 8d.; D. S. D. Co., electric cars, £454 6s. 8d.; total, £3,185 17s. 4d.; decrease, £20 13s. 4d; aggregate to date, £12,350 9s. 4d.; ditto last year, £12,534 14s. 5d.; decrease to date, £184 5s. 1d. Worked:—The mileage open is 18 miles electrically, 26 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending January 29th, 1899, amounted to £1,258; corresponding week last year, £1,337; decrease, £79.

The South Staffordshire Tramways Company.—The receipts for week ending January 27th, 1899, were £542 8s. 6d.; aggregate receipts for four weeks, £2,308 5s. 10d.; week ending January 28th, 1898, £568 19s. 11d.; aggregate receipts for four weeks, £2,353 16s. 8d.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, Jan. 25th.	Closing Quotation, Feb. 1st.	Business done during week ended Feb. 1st, 1899. Highest.	Lowest.
124,400£	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	87 — 92	87 — 92	...	...
905,560£	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	67 — 69	68 — 70	68½	...
3,047,220£	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	119½—120½	120 —121	120⅝	120
3,047,220£	Do. do. Deferred	Stock	...	...	18s. %	16½— 17	16½— 17	16¼	16 9/16
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	...	15⅝— 16¼	15⅝— 16¼	16⅛	15 13/16
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2¾— 3¼	2⅝— 3¼	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	180 —190	180 —190	...	...
1,332,523£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	105¾	103½
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	...	...	1/16— 1/16	1/16— 1/16	...	...
16,000	Cuba Telegraph	10	8 %	7 %	...	9½— 10½	9½— 10½	10 1/16	9⅝
6,000	Do. 10 % Pref.	10	10 %	10 %	...	17 — 18	17 — 18	...	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	..	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	10¼	...
30,000£	Do. do. 4½ % Debs., Nos. 1 to 6,000	50	4½ %	4½ %	...	104 —107%	104 —107%	...	...
60,710£	Direct United States Cable	20	2½ %	...	...	12 — 12½	12⅛— 12⅞xd	12 1/16	12
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	102 —105	102 —105	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	...	...	...	174 —179	175 —180	179	176
1,295,000	Do. 3½% Pref. Stock	100	...	...	...	103 —106	103 —106	104	...
500,000	Do. Prov. Certs., all paid	...	...	...	...	103 —106	103 —106	105⅜	...
89,900	Do. 5 % Debs., repayable August, 1899	100	5 %	5 %	...	101 —104	99 —102 xd	...	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	125 —129	125 —129	127½	126
1,250,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	...	17½— 18	17⅞— 18⅛	18 1/16	17⅞
16,200£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	99 —103	99 —103	...	...
64,400£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	126 —130	124 —128 xd	...	...
35,100£	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	99 —103	99 —103	...	...
46,500£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	100 —103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	104 —107	102 —106 xd	...	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	104 —107%	104 —107%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	...	12½— 13	12⅝— 13¼xd	13	12⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	16¾— 17¼	16⅝— 17¼xd	17⅛	16⅞
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	10 %	...	28½— 29½	29 — 30	28⅝	...
150,000£	Do. do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	101½	...
97,800	Halifax & Bermuda Cable, 4½% 1st. Mt. Dbs., w'n. 1-1,200, rd.	100	...	...	...	99 —102	99 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	57 — 60	58 — 61	60	59⅛
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	109 —112	109 —112	...	..
484,597	National Telephone, 1 to 484,597	5	5½ %	6 %	6 %	5⅜— 6	5⅜— 6	6	5 13/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	14 — 16	14 — 16	15½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	14½	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5½— 5⅝	5⅝— 5⅝	...	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	99 —102	99 —102	100½	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝— ¾	⅝— ¾	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	...	104 —107	104 —107	...	...
11,839	Reuter's	8	5 %	5 %	...	6½— 7½	6½— 7½	6⅝	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	138 —143	...	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4⅜— 5¼	4⅜— 5¼	...	...
151,733£	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	...	...
200,000£	West African Telegraph, 5 % Debs.	100	5 %	5 %	...	100 —103	100 —103	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	102 —105	103 —106	...	...
64,269	Western and Brazilian Telegraph	15	2 %	3½ %	...	12¼— 12⅜	12¼— 12⅜	...	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	...	8 — 8½	8 — 8½	...	...
33,129	Do. do. do. Def. Ord.	7½	nil	½ %	...	4 — 4½	4 — 4½	...	...
389,521	Do. do. do. 4 % Deb. Stock Red.	Stock	...	...	...	105 —108	105 —108	...	...
88,321	West India and Panama Telegraph	10	1 %	⅝ %	...	1⅝— 1⅞	1½— 1¾	1⅝	1 7/8
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	10¼— 10⅜	10¼— 10⅜	10½	10¼
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	104 —107	104 —107	...	...
158,100£	Western Union of U.S. Telegraph, 6 % Ster. Bonds	100	6 %	6 %	...	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	11 — 12	11 — 12	11⅝	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
34,000	*Chelsea Electricity Supply, Ord.,	5	5 %	6 %	...	8½— 9½	9 — 10	9¼	...
60,000	Do. do. do. % Deb. Stock Red.	Stock	4½ %	4½ %	...	113 —115	113 —115	...	...
50,000	City of London Electric Lighting rd. 40,001—90,000	10	7 %	10 %	...	23½— 24½	23½— 24½	23⅞	23⅜
10,000	Do. Ord. Nos. 90,001 to 100,000	10	...	...	...	22 — 24	22 — 24	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	15½— 16½	15½— 16½	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	125 —130	125 —130	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	nil	nil	...	12½— 13½	12½— 13½	13 1/16	13
10,000	Do. do. do. Nos. 30,001 to 40,000	10	...	...	...	12 — 13	12 — 13	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	14½— 15½	14½— 15½	14⅝	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	5 %	...	5 — 5½	5 — 5½	5⅜	...
15,661	House-to-House Electric Light Supply, Ord., 101 to 15,761	5	...	4 %	...	9 — 10	9 — 10	...	...
12,000	Do. do. 7 % Cum. Pref.	5	7 %	7 %	...	9½— 10½	9½— 10½	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	3½— 4	3¾— 4¼	4 1/16	3¾
48,050	Do. do. do. 6 % Pref.	5	...	...	...	6½— 7	6½— 7	6 15/16	6¾
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	102 —104	103 —105	104½	104
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	...	19 — 20	19 — 20	20	19¼
22,500	Do. Nos. 62,501 to 85,000, £4 paid	10	...	...	...	12 — 13	12 — 13	...	...
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	...	118 —121	118 —121	121	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	...	17 — 18	17 — 18	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½ %	14½ %	14½ %	17 — 18	17 — 18	17⅝	17⅛
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	9 1/16	...
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	3 — 3½	3⅜— 3⅝	3½	3 3/16
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	9 %	12 %	12 %	15½— 16½	15½— 16½	16	15⅜

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. || Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation Jan. 25th.	Closing Quotation Feb. 1st.	Business done during week ended Feb. 1st, 1899. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	...	...	...	3¼— 3⅜	3 — 3⅛	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	94 —100	94 —100	...	...
30,000	British Electric Traction	10	...	...	...	17½— 18½	17½— 18½	18	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13½— 14	13½— 14	...	...
100,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	119 —121	120 —122	120⅞	120¼
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	*nil*	*nil*	...	1⅞— 2⅛	1⅞— 2⅛	1 15/16	1⅛
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	*nil*	4 %	...	2⅛— 2⅜	2⅛— 2⅜	2 5/16	2¼
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	111 —115	111 —115	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	101 —104	101 —104	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	...	...	...	9½— 10½	9½— 10½	10¼	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	110 —113	110 —113	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	9¾— 10¼	9¾— 10¼	10⅛	9 15/16
178,303	Do. do. do. £8 paid	10	...	...	...	7⅞— 8¼	7⅞— 8¼	...	...
61,033	Do. do. Pref. half-shares £3 paid ...	...	...	...	...	3½— 4	3½— 4	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	4 — 4⅓	4 — 4⅓	4¼	...
630,000*l*	City and South London Railway	Stock	1 9/16 %	1⅞%	2⅛%	69 — 71	69 — 71	70⅛	69½
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £4 pd.	10	...	...	...	3½— 4	3½— 4	4	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	2½— 3	2½— 3	...	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	94 — 99	98 —101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5½%	6 %	...	2½— 3	2½— 3	2½	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5½%	6 %	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	97 — 99	97 — 99	99	98½
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2¼— 2½	2¼— 2½xd	2 5/16	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3⅛	3 — 3⅛	3⅛	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —105	103 —105	104½	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	¼— ½	⅜— ⅝	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	¼— ½	¼— ½	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	...	24 — 25	24½— 25½	25½	24⅞
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	...	18½— 19½	18½— 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	...	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	22 — 23	22 — 23	22 7/16	22¼
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	3¼%	3¼%	10½— 10⅝	10½— 10½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14¼— 15¼	14¾— 15¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	...	37 — 41	37 — 41	39⅝	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	...	...	...	...	...
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	8½— 9	8½— 9	...	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5¾— 6	5¾— 6¼	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	108 —111	109 —112	111	110

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.
British Aluminium, Ordinary, 10—12; 7 % Pref., 11—12.
House-to-House, 4½% Debentures of £100, 105—108.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 13—14; 1st Preference Cumulative 6%, £5 (fully paid), 7½—8. Debentures, 107—109%. Dividend, 1897, on Ordinary Shares 10%.

National Electric Free Wiring, 10s. paid, 8s. to 10s.
Smithfield Market Electric, 4¼—4⅜.
*T. Parker, £10 (fully paid), 16¼.

* From Birmingham Share List.

Bank rate of discount 3½ per cent. (January 19th, 1899).

MARKET QUOTATIONS, Wednesday, February 1st.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a „ Nitric .. .. .. per cwt.	22/-	22/-	..
a „ Oxalic .. .. .. per cwt.	32/-	32/-	..
a „ Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	37/-	37/-	..
a Ammonia, Muriate (grey) .. per ton	£19	£19	..
a „ „ (white) .. per ton	£26	£26	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 °/₀) .. .. per gal.	7/-	7/-	..
a „ (50/90 °/₀) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£23 10	£21 10	£1 inc.
a Lead, Nitrate .. .. .. per ton	£23	£23	..
a „ White Sugar .. .. per ton	£30 10	£30 10	..
a „ Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 °/₀ at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	3¾d.	3¾d.	..
a „ Caustic (75/80 °/₀) .. per ton	£24	£24	..
a „ Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	67/-	65/-	2/- inc.
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 15	£6 15	..
a „ Recovered .. .. per ton	£5 15	£5 15	..
a „ Lump .. .. .. per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 °/₀) .. per ton	£7 10	£7 10	..
a „ Crystals .. .. .. per ton	£3	£3	..
a Potash, Bichromate, casks .. per lb.	3d.	3d.	..

METALS, &c.	This week.	Last week.	Increase or Decrease.
b Aluminium Wire, in ton lots .. per ton	£224	£224	..
b „ Sheet, in ton lots.. per ton	£191	£191	..
c Brass (rolled metal 2" to 12") basis per lb.	7¾d.	7¾d.	..
c „ Tube (brazed) .. .. per lb.	9¾d.	9¾d.	..
c „ Wire, basis .. .. per lb.	8d.	8d.	..
d Ebonite Rod .. .. .. per lb.	3/-	3/-	..
d „ Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£79	£77	£2 inc.
g „ Wire (basis price) .. per lb.	9d.	9d.	..
g „ Sheet .. .. .. per ton	£79	£77	£2 inc.
g „ Rod .. .. .. per ton	£79	£77	£2 inc.
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	6/-	6/-	only 3 tons obtainable
h India-rubber, Para fine .. per lb.	4/3	4/1	2d. inc.
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i „ Pig (Cleveland warrants) per ton	47/8	48/8	1/- dec.
i „ Forgings, according to size per ton	From £11	From £11	..
i „ Scrap, heavy .. .. per ton	45/-2½	45/-	..
i „ Wire galvanised No. 8 .. per ton	£8 15	£8 15	..
g Lead, English Ingot .. .. per ton	£15	£13 10	30/- inc.
g „ Sheet .. .. per ton	£16	£14 10	30/- inc.
l Mica (uncut slabs 8" long) .. per lb.	6/6	6/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£8 5	£8	5/- inc.
o Platinum .. .. per oz.	£3 6 6	£3 1 6	5/- inc.
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£115	£113	£2 inc.
g „ foil .. .. per lb.	1/6	1/4	2d. inc.
n „ wire Nos. 1 to 16 .. .. per lb.	1/6	1/6	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	6¾d.	6¾d.	..
j „ Flax, 6 or 8 lea... .. per lb.	4d.	4d.	..
j „ Hemp, 8 ply 10 lbs. .. per lb.	3¾d.	3¾d.	..
j „ „ Russian, 10 lbs. per lb.	4¼d.	4¼d.	..
j „ Jute, 180 lbs. rove .. per ton	£12	£12	..
j „ Manila, 24 thread .. per ton	£30	£30	..
k Zinc, Sheet (Vielle Montagne bnd.) p. t.	£30	£28 10	30/- inc.

a Quotations supplied by Messrs. G. Boor & Co.
b „ „ „ The British Aluminium Co., Ltd
c „ „ „ Messrs. Thos. Bolton & Sons.
d „ „ „
e „ „ „
f „ „ „ The India-Rubber, G.-P., and Teleg. Works Co Ltd
g „ „ „ Messrs. James & Shakspeare
h „ „ „ Jackson & Till

i Quotations supplied by Messrs. Bolling & Lowe.
j „ „ „ „ Henry C. Yeo & Co.
k „ „ „ „ Morris Ashby, Limited.
l „ „ „ „ Sanders, Wake & Co.
m „ „ „ „ W. T. Glover & Co., Ltd.
n „ „ „ „ P. Ormiston & Sons.
o „ „ „ „ Johnson, Matthey & Co., Ltd

INSTITUTION OF ELECTRICAL ENGINEERS.

"Telegraphy by Magnetic Induction." By S. Evershed, Associate. (Read December 22nd, 1898.)

(*Concluded from page* 143.)

Transmitting Devices.

It is not necessary to discuss in any detail the apparatus required for producing the alternate or interrupted current in the primary circuit. An interrupted current may be derived from batteries by means of a rotary contact wheel driven by clockwork or by an electro-motor. For telegraphing over great distances the primary power must be considerable, and it will probably prove more economical and convenient to have a small alternator driven by an oil or gas engine. No particular difficulty is likely to be met with in designing a compact plant for the purpose.

Receiving Devices.

In every instance, so far as the author is aware, in which communication has been carried on by magnetic induction or by earth leakage, the ordinary Bell telephone has been used as a "sounder." It is well adapted for the purpose, as it enables exceedingly minute currents to be detected. This sensitiveness does not arise so much from the efficiency of the telephone as a current-detector as from the marvellous delicacy of the human ear, which is able to distinguish sound waves produced by motions so exceeding small as to be absolutely invisible, even when magnified many times. In the course of the investigation already referred to the author made careful measurements of the magnetic and electrical quantities involved in the telephone, but up to the present he has been unable to devise adequate means for measuring what fraction of the electrical power supplied is converted into mechanical power. This conversion can be estimated for any given amplitude of the diaphragm from a knowledge of the change in induction threading the coils for different displacements of the diaphragm; obtaining in this way the back E.M.F. But the difficulty remains of determining the amplitude when an alternate current is flowing in the coils.

However, in the case of the telephone it is not essential to know the mechanical power in order to ascertain the conditions for working to a given distance. By measuring the alternate current required to produce readable signals, it is possible to deduce with fair accuracy the distance over which Morse code signals can be sent. The author has measured the current flowing in a Post Office pattern Gower-Bell telephone while receiving Morse signals readable by a skilled operator in a quiet room—"readable" implying that the message could be read without difficulty. Two operators were found to agree very closely in their estimate, and it appeared that the current for readable signalling was nearly twice the minimum current which produced an audible sound. The current was determined by connecting the telephone to a circular ring of wire through which a measured induction was alternating. The resistance and self-induction of the telephone were separately determined, and the whole impedance was sufficiently large to enable the current to be estimated without reference to the back E.M.F. of the vibrating diaphragm. The mean of several observations gave for the maximum (crest of wave) value of the readable current,

$$C = \frac{2{\cdot}9}{10^6} \text{ amperes.}$$

A current of one-half the above value makes a just audible sound.

When a telephone of this type is used as receiver on the secondary of an induction telegraph, the only condition to be fulfilled to get the best effect is that the resistance of the secondary circuit should equal that of the telephone. This is only another way of saying that the telephone is a very badly designed motor, with such an enormous combined resistance and inductive drop that the current is quite independent of its back E.M.F. A large component of the current—namely, that required to force the vibrations—is, of course, in step with the diaphragm, and therefore in quadrature with the back E.M.F.; in short, an idle* current in the sense that it does no mechanical work.

Suppose this particular telephone is connected to the secondary of the two circuits which are given above as an example. To get maximum current we must either wind the telephone to equal the line resistance, or divide v_s into a sufficient number of turns to bring R_s up to the resistance of the telephone. The resulting ampere-turns in the telephone coils is the same in either case, and it will be simpler to choose the latter alternative, although in practice the telephone would, of course, be wound to suit the line. Using the same notation as before, and calling x the impedance of the telephone coils at frequency F, we have first to make

$$\frac{16\,\rho\, s^2\, N_s^2}{v_s} = x;$$

that is,

$$N_s = \frac{\sqrt{v_s\, x}}{4\,p\,\sqrt{\rho}}.$$

Now,

$$C_s = \frac{E_s}{2\,x} = \frac{p\, s^3\, N_s\, \sqrt{w_p\, v_p}}{8\, D^3\, x\, \sqrt{\rho}}$$

and, substituting the value just found for N_s, we find

$$C_s = \frac{p\, s^2\, v_s\, \sqrt{w_p}}{128\, D^3\, \rho\, \sqrt{x}} \qquad (5)$$

Working out the value of C_s from the data already given, the frequency being now 400 ~ per second—the rate adopted by the Post Office after many trials at different speeds—and the impedance of the telephone $x = 220$ "ohms" at 400 ~, we find

$$C_s = \frac{12}{10^6} \text{ amperes;}$$

that is to say, a little more than four times (4·1) the minimum for readable signals; so that the weight of copper in the lines might be cut down to a quarter of a ton, or the distance increased by multiplying by $\sqrt[3]{4{\cdot}1}$, making the distance between the centres of primary and secondary circuits 16 kilometres (10 miles).

It is clear, therefore, that in the absence of wave-absorption an ordinary telephone without any modification will enable induction telegraphy to be carried on at considerable distances. In the absence of any measurements of the absorption of electro-magnetic waves by the earth it is, of course, impossible to predict to what distance it will be possible to signal by means of a system working at 400 periods per second, but the author is inclined to think that at this speed absorption will rapidly damp out the waves as the distance increases.

The telephone may easily be improved for signalling purposes. When articulation is not required the pitch of the diaphragm may be lowered with advantage. During the working out of the apparatus for the lightship telegraph Mr. Cox devised several forms of telephone sounders in which the coil was rigidly attached to the diaphragm, and adapted to move in a powerful magnetic field. One or two instruments of this type were made, and worked well. Time, however, did not allow of our bringing any of them to perfection. But in whatever way the telephone may be improved as a motor, the most serious difficulty will always remain. To get an easily audible note it is necessary to work at a fairly high frequency. At 100 periods per second one can just hear a low hum in a telephone, but it is not until the frequency reaches 200 or 300 that dots and dashes become at all distinct. At 400 periods the note is sufficiently piercing to enable an operator to read a message without any serious strain.

Whatever form the telephone as a "sounder" may ultimately take, its suitability for induction telegraphy must depend on the degree of absorption met with in practice. If absorption is serious, audible indications must be abandoned, and an indicator working at a very low frequency will become necessary. What form such an indicator should take for Morse code signalling is by no means clear, but a simple form of vibratory indicator devised by the author in 1892 for use in connection with the light-vessel experiments may be described, as it illustrates very clearly the principles involved in all vibratory indicators of minute alternate currents, and possibly contains the germ of a practicable "speaking" instrument.

The essential parts of the author's indicator are shown in fig. 1. A rectangular loop of fine wire, a, b, c, d, is fixed in an insulating

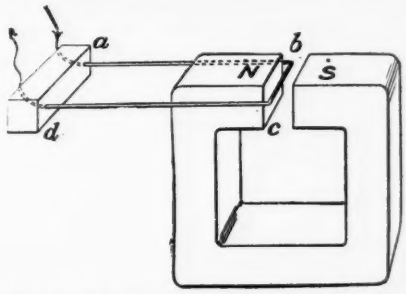


Fig. 1.—Vibrating Rectangle, with Magnet.

block in position which allows its end, b—c, to move freely in the air gap of a magnet, N S. When the rectangle is traversed by an alternate current, it vibrates up and down about its fixed ends, a—d, and if the rectangle is tuned so that its free period of vibration is equal to the periodic time of the current, it becomes an exceedingly sensitive alternate-current voltmeter, the amplitude being strictly proportional to the impressed E.M.F. on the terminals of the rectangle.

By combining the mechanical equation of motion with the equation of the electrical quantities concerned, the following simple equation is arrived at for the amplitude in terms of the molecular and other frictional resistances to motion, the condition of synchronism or resonance being assumed:—

Let

- a = amplitude at end b–c.
- r = force required at end b–c to overcome frictional resistances at unit velocity.
- R = electrical resistance of circuit, including rectangle.
- L = self-induction of circuit, including rectangle.
- E = impressed E.M.F.
- $h = H\,l$ = field in air gap × length b–c.

Then

$$a = \frac{E\,h}{p\,\sqrt{(h^2 + {}_B r)^2 + r^2\, p^2\, L^2}} \qquad (6)$$

* The author regrets to see that Dr. Thompson sanctions the inappropriate phrase "wattless current" for a current in quadrature with the E.M.F. Such currents are, alas! only too watt*ful*—they are never watt*less*. But they are distinctly idle, in that they never do any useful work.

Also, if i and v are instantaneous values of the current in, and velocity at end of rectangle,

$$h\,i = r\,v,$$

and the maximum velocity is $p\,a$; so that, if C is the maximum value of current,

$$C = \frac{r\,p\,a}{h}.$$

Also the maximum back E.M.F. $= V = p\,a\,h$; hence maximum power is

$$V\,C = r\,a^2\,p^2 \qquad (7)$$

By differentiating (6) it is seen that a will have the greatest possible value when the field is adjusted until

$$h^2 = r\,\sqrt{R^2 \times p^2\,L^2}.$$

Writing B_1 for $\sqrt{R^2 + p^2\,L^2}$, we have for the value of amplitude under most favourable conditions,

$$a = \frac{E}{p\,\sqrt{2\,r\,(R + B_1)}} \qquad (8)$$

The condition for maximum amplitude is clearly that for maximum activity also, and accordingly we find that when $L = 0$ and $h^2 = R\,r$, the back E.M.F. is equal to half the impressed E.M.F.

So much for the theory of this simple alternate-current synchronous motor. It is gratifying to add that its actual behaviour is, within the limits of observational error, strictly in accordance with theory.

By adding a fixed contact screw adjacent to the free end of the rectangle a local circuit will be closed whenever the vibrations are sufficient to make the rectangle touch the contact screw. Another and better arrangement is to have two rectangles connected to two separate secondary circuits in such a direction that they oscillate in opposite phase. The two rectangles being made, the poles of a local circuit can be made to act as a relay on coming into contact with each other. Two relays of this type were made by the author's firm in 1896 for use in the light-vessel trials, and a few months ago they were attached to the wireless telegraph erected by the Post Office for communicating between Lavernock and Flat Holm, in the Bristol Channel. They are in daily use as relays for closing a call-bell circuit. The primary current is derived from a small alternator with a very heavy fly-wheel on the armature shaft. The machine being driven by hand to a speed above the synchronising frequency, the exciting current is switched on, and the alternator allowed to come gradually to rest, passing slowly through the synchronising speed, so that the two rectangles of the distant relay have time to come to their maximum amplitude.

The rectangles in these two relays are made of iridio-platinum wire 3 mils in diameter. They are each 4 cm. in length, 2 cm. in breadth, and their frequency is 16 periods per second. The twin-rectangle relay has one great advantage over the single pattern shown in fig. 1. When the twin rectangles are properly tuned to unison, it is almost impossible to bring them into contact by shaking the instrument. Even when the contact points of the rectangles are separated by only 0·002 inch, it is difficult to make contact by shaking the relay. They may be oscillating over a large angle; appearing to overlap each other, but oscillating in unison and in the same phase, as the rectangles do when shaken, they do not come into contact. These relays were designed for use on board a light-vessel, and entire freedom from accidental contact due to shaking was, of course, essential.

Measurements of the value of the frictional resistances of rectangles made of copper, platinum, and iridio-platinum were made, and showed very little difference between them. The value of r was determined by means of a vibrator like fig. 1, having its field produced by an electro-magnet, so that h could be varied. The process consisted in observing the amplitude at synchronism for different values of h, and plotting the curve connecting them. There being no self-induction in the circuit, the amplitude follows the law,

$$a = \frac{E\,h}{p\,(h^2 + R\,r)}.$$

The impressed E.M.F. was provided by a secondary circuit of a single turn in which the total induction, B, could be measured. That is to say, $E = p\,B$; so that

$$a = \frac{B\,h}{h^2 + R\,r} \qquad (9)$$

Having plotted the observed values of a and h, a curve is determined by means of equation (9) to fit the observed points as closely as possible. One of the curves is given in fig. 2. It shows the relation between a and h for a rectangle of iridio-platinum wire 3·3 mils. diameter and 2·9 cm. long, having a frequency of 25 periods per second. The curve is drawn from the equation,

$$a = \frac{1{,}770\,h}{h^2 + 25 \times 10^6}\ \text{cm};$$

so that $R\,r = 25 \times 10^6$ C.G.S. units.

Now $R = 4{\cdot}28$ ohms $= 4{\cdot}28 \times 10^9$ C.G.S. units; hence

$$r = \frac{25}{4{\cdot}28 \times 10^3} = \frac{5{\cdot}85}{1{,}000}\ \text{dynes.}$$

In the relays on the Lavernock-Flat Holm telegraphs the greater length of rectangle—4 cm.—results in a lower value for r, namely,

$$r = \frac{4{\cdot}0}{1{,}000}\ \text{dynes.}$$

The power required to work a 4-cm. rectangle at any amplitude can now be calculated from the value for r just given, and the known frequency—16 periods per second—for, as we have already seen, the mechanical power expended is

$$M = r\,a^2\,p^2.$$

Let $r = \frac{4}{1{,}000}$, $a = \frac{1}{10}$ cm., $p = 2\pi \times 16 = 100$:

then $M = 0{\cdot}4$ ergs per second ($a = 0{\cdot}1$ cm.);

or if $a = 0{\cdot}01$ cm.,

$M = 0{\cdot}004$ ergs per second ($a = 0{\cdot}01$ cm);

and so on.

An amplitude of $\frac{1}{10}$th of a millimetre is, however, far more than is necessary under favourable conditions. The author has repeatedly worked a twin-rectangle relay with less than 2 mils between the contacts, and a relay was purposely set up at Woodfield Works with the contacts 2 mils apart to ascertain how often accidental shaking

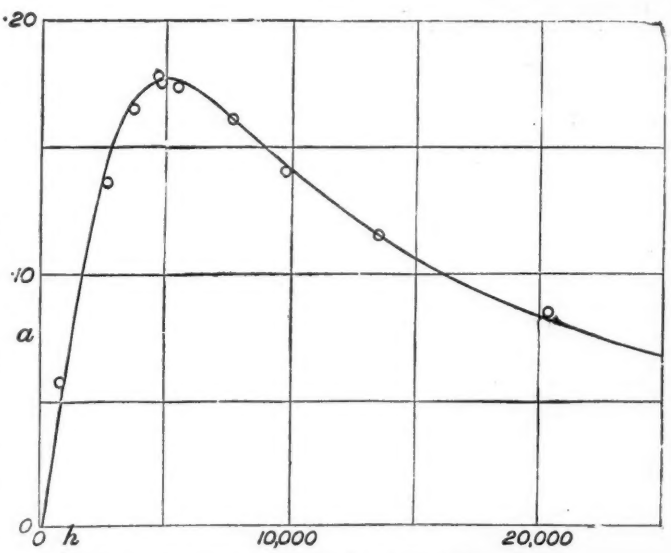


FIG. 2.—CURVE CONNECTING a AND h FOR IRIDIO-PLATINUM RECTANGLE; a IN CENTIMETRES, h IN C.G.S. LINES.

made contact. The relay was tested every day by alternate current to see that it was in working order, but in the course of a three weeks' trial no accidental contact occurred.

Taking 2 mils—say, 0·005 cm.—as the limiting value for the clearance between contacts, the mechanical power expended becomes

$M = 0{\cdot}001$ ergs per second ($a = 0{\cdot}005$ cm.).

This must be considered as the limit of sensibility for this particular relay. When the clearance is reduced to less than 2 mils, difficulties arise from the electrostatic attraction between the rectangles drawing them into contact, and when in contact the elastic force of the wires is insufficient to pull them apart again.

It is clear, however, that the energy received in a secondary circuit can be detected by means of a synchronous vibrator of the kind described in which frictional resistance has been reduced to 4×10^{-3} dynes. Returning to equation (4a), and assuming the resistance of the rectangle is negligible compared with the least possible resistance of the secondary circuit, we can now write—

$$M = r\,a^2\,p^2 = \frac{\pi^2\,s^4\,w_p\,v_t^2}{32^2\,D^6\,\rho^2}.$$

Hence,

$$a = \frac{s^2\,v_t}{32\,D^3\,\rho}\sqrt{\frac{w_p}{r}} \qquad (10)$$

When, as in the former example, $v_t = 1{\cdot}1 \times 10^5$ c.c., $s = 10^5$ cm., $w_p = 200$ watts, $D = 10$ kilometres, $\rho = 1{\cdot}7 \times 10^{-6}$ ohms, and, in addition, $r = 4 \times 10^{-3}$ dynes, the amplitude will be

$a = 0{\cdot}014$ cm. (about 5½ mils);

so that, if the rectangle is used as a relay, and set to its maximum sensibility, it would be possible to work with a weight of copper amounting to

$$1{,}000\ \text{kilos.} \times \frac{0{\cdot}005}{0{\cdot}014} = 350\ \text{kilos.},$$

or about ⅓rd of a ton.

Or, still using 1,000 kilos., the distance may be increased by multiplying by $\sqrt[3]{\frac{0{\cdot}014}{0{\cdot}005}} = 1{\cdot}42$, bringing up the distance to 14·2 kilometres—a value only a little less than the limiting distance found for readable signals with a telephone as receiver. A very small rate

of absorption of waves would, however, tell enormously against the telephone, while the vibrating rectangle, working at so low a frequency as 16 periods per second, would not be appreciably affected.

It is interesting to note that when the telephone and the rectangle are worked under exactly the same conditions as regards primary power and distance and size of circuits, but at frequencies of 400 and 16 periods respectively, the total power available for the telephone is more than 600 times as great as that available for the rectangle. Yet the rectangle gives a *visible* indication—for by means of a magnifying glass the vibrations are easily visible down to about half a mil.

It has already been remarked that this synchronous vibrator may contain the germ of a "speaking" instrument. It has ample sensibility for practical purposes, and is not likely to be affected by a moderate rate of absorption. It is to be hoped that some means will be discovered for enabling it to be used for indicating Morse code signals, either directly or by employing it as a relay.

Absorption.

So far as the author is aware, the absorption of electro-magnetic waves by the earth—considered as a solid conductor—has never been calculated or measured under the conditions assumed in this paper. What is wanted is a complete series of observations of the absorption at different frequencies and over different distances, and it would be desirable that observations should be made in several different localities of widely differing geological character. The author hopes to be able to carry out at least a part of this investigation in the course of the next few years.

Apart from absorption, it is clear that communication by magnetic induction can easily be established in those cases where the ordinary telegraph line or cable is impracticable. The author has endeavoured to illustrate the fundamental principles involved in the working of induction telegraphs, and if he has in any way cleared the ground for future investigators and thrown a little light on matters relating to the design of appropriate receiving apparatus, the object of this paper will have been fulfilled. In conclusion, the author desires to express his sense of the great obligation he is under to Mr. Preece and Mr. Gavey for their kindness in giving facilities for his investigations, and placing at his disposal the results of the many experiments carried out by them in connection with wireless telegraphy.

"The Institution Wiring Rules." By R. E. Crompton, past president. Read January 12th, 1899.

Nearly four years have elapsed since the Council decided that the Institution wiring rules should be revised. A committee was then appointed to deal with the matter, and subsequently sat throughout the greater portion of two sessions, with the result that the revised rules were issued in July, 1897.

I have discussed these rules with several gentlemen who are competent to express an opinion on the matter, and I find the general feeling to be that the labours of our committee were not misspent, and that the rules in their present form are, of all those now in existence, the best fitted to become the standard set accepted by all parties.

My object, therefore, in writing this note is to try and promote the adoption of the Institution rules as the standard rules to be prescribed by consumers, insurance companies, and municipal authorities, and to be worked to by wiring contractors. Of these four classes, the fire insurance companies are, of course, the most interested, as they act as guarantors of the safety of installations passed by them; and it is to the gentlemen who act as inspectors and technical advisers to the insurance companies that I primarily address myself. The objects which the committee had in view when framing the present rules were identical with those of the fire insurance companies, every principle laid down and every detail described having for its object the avoidance of fire risk. I say this advisedly, for although some few details were intended to prevent either danger to person from shock, or discontinuity of supply, yet even in guarding against these dangers we are indirectly guarding against fire risk also. At present there are issued by fire insurance companies several distinct sets of rules, differing among themselves, indirectly in principle, but, mainly, in the size and carrying capacity allowed for the conductors and in small matters of dimension. In these respects I believe the Institution rules occupy a midway position—that is to say, they are more stringent than some and less so than others; but all are dealing with the same questions of electrical supply and with the same fire risks. Why, then, should this diversity in rules continue? Is not this the time for us to invite insurance inspectors to appoint a committee to decide in what points the Institution rules can be improved, made more (or less) stringent, or added to, so that they may be satisfactory to all, and may thus establish that uniformity, which will undoubtedly result in simplifying the work of contractors, and which therefore, assuredly, in the end, will give the consumer better value for his money? The committee throughout tried to place themselves in the position of fire insurance inspectors, and if I recollect aright, the rules in their draft condition were sent out to a number of inspectors for their criticisms and remarks; and all criticisms received were accepted and dealt with as far as possible. If it is a fact that these rules differ in points which fire insurance inspectors consider vital, now is the time for these gentlemen to come forward and give us the opportunity of amending or supplementing them; but I sincerely hope that this discussion will open the eyes of everyone to the desirability of uniformity, and to the great waste of time, and the annoyance to consumers and everyone concerned, that arise from the multiplicity of rules which at present exists. It has been said that the Institution rules cannot be enforced. It is true that the Institution as a body cannot enforce its rules, but in drawing them up it did the next best thing—it appointed, from amongst those of its members who were best qualified to deal with this matter, a committee to draw up a set of rules which would be a guide to any consumer, and which could be adopted and enforced by anyone having the requisite authority. In fact, all that is now required is, that wherever the words "should be" occur in the rules, the words "must be" should be substituted.

"The Regulation of Wiring Rules." By C. H. Wordingham, Member. (Paper read January 26th, 1899.)

The question of the conditions necessary to be attained in order to provide for safety from fire, and reliability in the utilisation of electrical energy for various purposes, has attracted a very large amount of attention from the earliest days of the industry, and numerous sets of rules and regulations have been promulgated from time to time. Many different authorities have taken upon themselves to issue these rules, and inasmuch as there are various conflicting interests in an installation of electric light or power, and as each authority is determined to abide by its own particular rules, the difficulties of the wiring contractor are many and great. In consequence of this, and for other reasons, there is at the present time a very widely diffused feeling that there should be some definite standard set of rules by which everyone will agree to be bound.

In considering this matter, it is important to recognise that there is an essential difference between the rules necessary to secure efficient and safe wiring, and those, equally necessary, to secure a satisfactory utilisation of the public supply of electrical energy. The former will, practically speaking, be independent of the system of supply. The latter will vary greatly with the nature of the distribution adopted by the supply company, and also to some extent with the local conditions existing in the town in which the supply is given. It does not appear to the author that this fact has been sufficiently generally recognised. It would appear to him quite possible, and undoubtedly most desirable, to draw up a set of regulations for wiring and fittings which should be of universal application; but so far as the public supply authorities' regulations are concerned, it will be necessary either to draw up a single model set of regulations which can be modified for every particular case, or several standard sets of regulations to suit different systems of supply which might possibly meet with general acceptance. In all probability, however, the former would be the more likely to meet with success.

It is important to consider, when framing regulations, what power exists to enforce them. This point was fully discussed by the author in a paper read at the 1896 Convention of the Municipal Electrical Association.* It was then shown that the power given in the Electric Lighting Acts is extremely unsatisfactory, and does not by any means give the undertakers a sufficiently strong hand to deal effectively with wiring contractors, and the course adopted by Glasgow was advocated by the author for imitation by other towns. Since then the same powers have been sought and obtained by Manchester, and there should be no difficulty in similar powers being obtained in all cases where municipal authorities are the undertakers. The course referred to is to obtain a special Act to make the regulations in question. In the case of Glasgow, this formed part of the Glasgow Buildings Regulations Act, 1892. In the case of Manchester it formed part of the Omnibus Act, known as the Manchester Corporation Act, 1897, Section 40.

It might be somewhat difficult for existing companies to obtain similar powers, but the experiment would be well worth trying.

To consider, first, the question of wiring regulations properly so called. There are several excellent sets of rules in every-day use, but the author ventures to think that those issued by this Institution are the best that have yet been produced. They are the outcome of the most careful deliberation, and no one rule was drawn up until it had been most thoroughly discussed by men actually engaged in the work affected. Indeed, it may be said, without any hesitation, that these rules represent the unbiased opinion of electrical engineers at the present time as to the best means of securing safety from fire and efficient utilisation of energy.

It is greatly to be regretted, however, that no matter how good the rules may be, they, in the existing state of things, can only be suggestions, and when individuals have drawn up other regulations which they have found to work well in practice, and with the details of which they are thoroughly acquainted, they are extremely loth to adopt "suggestions."

The only possibly way in which uniformity can be attained is by first of all thoroughly thrashing out the whole question at one or more meetings, in which all the parties interested are adequately represented. When this has been done it should be possible finally to decide upon a set of rules which will cover the whole of the points raised in the discussion, and then, if every person will abide loyally by the decision arrived at, the desired result will be attained; but it is futile to hope for this unless persons will sink their own individual preferences, and it may be their own *amour propre*.

It is not the author's object in this paper to enter into the question of particular regulations. He had the honour of forming one of the Committee that drew up the Institution rules, and he might fairly say that these rules are, in his opinion, as good as can be drawn up at the present time; but a few words may not be out of place on the general question of enforcing rules when made and agreed upon.

There is, in the author's opinion, great necessity at the present

* See *Proceedings* Municipal Electrical Association, p. 30, "The Control by Municipal Authorities of Consuming Devices, and the Wiring Connecting them to Mains."

time for the proper supervision of fittings used in connection with electric lighting and motive power. By fittings it is intended to imply such apparatus as fuses, switches, ceiling roses, wall sockets, lampholders, &c., not ornamental electroliers, brackets, &c., which are after all only metallic casing for wiring. Quite recently the author has introduced into Manchester a system of testing and registration of such fittings. It has only been in operation for a few weeks, but the results are eminently satisfactory. It is found that all makers of repute welcome the action taken, that they are anxious to submit samples, and that they see the value of the certificates and the advantages that will accrue to them by the official recognition of their wares. At the same time, while the manufacturers are benefited, wiring contractors derive great convenience from being no longer in doubt as to what fittings will or will not pass inspection, and further, consumers have the satisfaction of knowing that the apparatus fixed on their premises has been certified by an unbiased authority.

It has long been the practice to test and stamp fittings intended to be used in connection with the supply of water, but, so far as the author is aware, no attempt has hitherto been made to apply this system to electrical fittings. The treatment necessary in the two cases differs materially, for whereas in an ordinary house but few taps are required in connection with the water supply, the same house would require a large number of electrical fittings, hence it is not possible to attempt actually to test and certify every individual fitting. The course adopted by the author, therefore, is to require manufacturers to submit in duplicate samples of the fittings they propose to supply in Manchester. One of the duplicate samples is then subjected to certain tests, and if it fail to pass, the two samples are returned to the manufacturer; if, on the contrary, it conformed to the regulations, the second sample is preserved and kept for reference, so that it may be seen by any contractor or consumer, and a certificate is issued stating that the article in question has been tested and found to conform to the regulations, and may be used. This certificate remains in force for one year, but may be renewed from year to year without further tests. It would be tedious to enter into all the regulations affecting this registration, but members desirous of further information will find a copy of the rules in the Institution library, and the author will be happy to forward a copy to any member desiring to have it.

The author was led to take the step in question very largely in consequence of the extreme difficulty, amounting almost to an impossibility, which exists in defining the conditions necessary in such articles as switches and fuses to ensure safety. This fact was very strongly impressed upon the members of the Institution Committee when drawing up the wiring rules, and at the author's suggestion it was thought that instead of specifying a given length of break, height of cover, &c., it would be far preferable to specify certain conditions which a given fitting should fulfil.

In Manchester the tests specified for a fuse are that when duly fitted up with its cover in position and connected to mains giving the pressure for which it is intended, it shall break the circuit when those mains are short circuited through it with a fuse wire corresponding to its rated capacity, placed between its contacts. In carrying out these tests the fuse is tested in three positions, namely: (1) with the base horizontal; (2) with the base in a vertical plane, the fuse wire being horizontal; (3) with the base in a vertical plane, the fuse wire being vertical.

For switches the conditions specified are that a switch when used in the ordinary manner shall be capable of breaking a current 50 per cent. in excess of that for which it is rated at a pressure 50 per cent. in excess of that at which it is intended to work. In addition to these tests there are other tests to ensure that the parts are properly proportioned to prevent heating.

It may seem that the tests set forth are unduly severe. As a matter of fact, the better class of fittings are found to conform to them with ease, and therefore on this score there can be no objection to the tests.

It may be said that so far the subject has been considered chiefly from the central station point of view, and that reference has not been made to consulting engineers. Undoubtedly they are in a different position, but on the other hand, they are in a much stronger position than undertakers not possessing special powers, because the contractor working under their supervision is working to a definite specification, under which large powers are given to the engineer. In the author's opinion it would be a considerable boon to consulting engineers, and would tend greatly to uniformity in practice, if some central authority—which, seeing that the Board of Trade is probably out of the question, should certainly be this Institution—were to undertake the testing of fittings in a somewhat similar manner to that adopted for local work by the author. It should not be a matter of extreme difficulty to establish a small testing station for the purpose, and it could readily be made self-supporting, for manufacturers would doubtless be prepared to pay a substantial fee for the testing and registration of their fittings, if the certificates issued carried the weight of the Institution behind them, for they would greatly enhance the value of their wares. Were such a body as the Institution to undertake this work, consulting engineers would feel every confidence in specifying certified articles, and they would feel assured that their clients would obtain satisfactory apparatus.

The author is aware that fittings are not the only things demanding attention. There is the question of the best kind of insulation to employ for the conductors, and the best kind of casing; but these matters are fully dealt with in the Institution rules, which are so drawn as to admit every existing system, the efficiency of which has been demonstrated in practical work. We may therefore leave the subject of wiring regulations, and pass on to that of regulations made by undertakers for the efficient supply of energy to the installations of consumers connected to their mains.

Systems of distribution may be divided broadly into two-wire and multiple wire, each class being further sub-divided into continuous current and alternating.

The most widely employed system of distribution at the present time is the multiple wire, and perhaps the more important subdivision of this is that in which continuous current is distributed, for there can be little doubt that the use of this will largely extend in the near future. Now, for multiple wire distribution, it is essential that the balancing of the circuits should be good, and for this reason it is most important that contractors should be required so to split up their circuits that they may be evenly divided between the various pairs of mains. For practical purposes it may be said that the three-wire system will be the most widely used, and therefore contractors should be required to divide their installations into two approximately equal circuits when a certain demand is exceeded. In Manchester this limit has been fixed at a low figure, namely, 12½ kilowatts, but the author ventures to think that the results attained by proper balancing entirely justify the slight inconvenience which may be said to be experienced in consequence by the contractor. As a matter of fact, this inconvenience with modern good wiring is not great, for it has become the practice to effect the sub-division in any case, and to limit greatly the number of lamps on a single circuit. Therefore, in practice, the only hardship is the provision of two small main switches and fuses instead of one large one. Again, in order to secure efficient balancing, it is important that, as far as possible, all motors should be supplied from the two outer conductors. For this reason the author has required in Manchester that all motors exceeding 2½ kilowatts shall be wound for 400 volts. In practice there is no great hardship in this, and the result to the central station engineer is, that he is practically supplying all his motive power on the two-wire system at 400 volts. Consequently, so far as motors are concerned, he has no trouble as to balancing.

In every system of distribution, whether two-wire or multiple wire, it is important to guard against sudden rushes of current, and therefore it is important to draw up rules with regard to the gradual starting of motors. This involves special switch gear and interlocking arrangements between switches, but the difficulties are such as can be readily overcome. In the case of large photographic or stage arc lamps it is necessary to take similar precautions, and, of course, in the case also of charging batteries or working electric furnaces.

Another important point which will require different treatment according to the system of supply, is in connection with the earthing of one of the conductors. In the case of a continuous current supply on the multiple wire system of distribution, it does not appear to the author desirable to allow any portion of the consumer's wiring to be directly connected to earth whether the middle conductor of the system be insulated or not. There is much to be said in favour of the middle conductor being earthed at the central station, and something against it, but the reasons against earthing one conductor of the consumer's installation are extremely cogent, the most important being that although on the whole the balancing on the network may be extremely good, there must of necessity in some streets be a local want of balancing, causing heavy currents to flow through the middle wire. If, then, there be two consumers separated by a few hundred yards, both having one conductor earthed, and if there be a heavy current flowing down the middle wire and causing a fall of potential of several volts along that wire, there will then be currents set up in the earth from the earth conductor of one consumer to that of the other, and the result may be serious electrolytic troubles—worse, in fact, than might arise from an improperly bonded tramway return. This reason alone appears sufficient to the author to preclude a system of wiring which requires the earthing of one conductor in a consumer's installation. The same objection does not apply with equal force if the distribution be effected by means of alternating currents, though in this case trouble may be anticipated if an earth return be used on the local telephone service. The author desires it to be understood that it is on these grounds alone that he deprecates an earth return system of wiring; for isolated installations there is much to recommend it, and also in cases in which the system of supply is a high pressure one and each consumer is supplied from his own alternating current transformer.

From what has been said it will be seen that the regulations comprised in this second group are of a totally different nature from wiring regulations proper, and the contention that they cannot be made absolutely uniform will probably be thought justified. The matter is one that affects chiefly central station engineers, though, of course, the views of contractors, and particularly of manufacturers, should be given due weight to. It would be most useful if some general consensus of opinion as to the best rules for given systems of distribution could be obtained. The matter has received the attention of the Municipal Electrical Association for some time past, and a Committee of their Council is at the present time drawing up a model set of rules for the use of municipal stations. It is greatly to be desired, however, that a general set of rules acceptable also to the engineers to companies should be decided upon.

ECONOMY OF MECHANICAL DRAUGHT.

Some years ago the writer encountered an instance of economy by the use of cheap fuel and fan draught, which was very striking. In place of expensive coal, coke sweepings or breeze was the principal ingredient of the fuel, the other being a little bituminous dust in sufficient quantity to produce adherent effects of the mass when heated. The draught was produced by a fan and, though there was an additional charge for clinkering, the bars becoming cemented with

clinker which required to be occasionally chipped off, the saving was considerable.

The question of economy by the use of cheap fuels has been accorded considerable attention in America where their hard anthracite is sold in carefully graded sizes. The grading is done, we believe, by revolving sieves which separate out always the larger pieces, and in this manner anthracite coal can be bought of one practically uniform size of particles down to mere dust. By the use of a uniform fuel the operation of a fan draught is greatly facilitated.

In the *Electrical Engineer* (New York), Mr. Snow, who is interested in selling fans, quotes Mr. E. B. Coxe to the effect that it is almost impossible to obtain sufficient chimney draught to burn the smaller sizes of anthracite, and mechanical draught presents the solution, for by it, any intensity may be secured which is best suited to the furnace.

Though there is no absolute parity in England of the American anthracite coal the following table may be useful as a guide. In it five sizes of successively smaller coal were tested by the late E. B. Coxe, with a view to finding their rate of combustion and the necessary intensity of draught:—

Kind of coal.	Rate of combustion per square foot per hour.	Lb. evaporation from and at 212°.	Water gauge of draught.	Maximum size of coal particles.
Pea coal	13·63	8·56	0·375	$\frac{7}{8}$"
No. 1.—Buckwheat	13·58	7·94	0·500	$\frac{9}{16}$"
„ 2.— „	11·40	8·60	0·625	$\frac{5}{16}$"
„ 3.— „	11·34	8·65	1·040	$\frac{3}{16}$"
„ 4.—Eckley ...	9·44	8·75	1·125	$\frac{3}{16}$"

Here practically the smaller coal showed the better evaporation though it burned at a less rate per square foot of grate and required heavier blast. The grate was a traveller, the blast being maintained beneath it. The notable point is the rapid increase of draught, approximately proportionate to the linear dimensions of the fuel particles. Some tests of efficiency of coals by Barrus confirm what has often been stated in these columns, that small coal is as good as large coal in so far as its calorific value, though it cannot be so well utilised. Nevertheless, it is usual proportionately more cheap than it is more inefficient. Thus in a descending series from Cumberland to Nova Scotia culm the water evaporated ranged down from 11·04 to 8·42 lbs. so that the relative efficiency of the lowest coal was 76 per cent., while a mixture of one-third Cumberland with two-thirds pea and dust coal gave 85 per cent. The Cumberland coal cost $3.75; Nova Scotia culm cost only $2. Yet calling the evaporative efficiency cost per 1,000 gals. 100 in case of the Cumberland coal, it was 156 for the culm, only 64 for $5.00 anthracite, and 123 for the mixture named above, which cost $2.58.

The evidence is thus altogether in favour of the cheap fuels. Against this, of course, must be set the question of boiler power, or more properly, grate area. The inference is, that our rule is correct which we have before laid down, that the cheapest fuel must be used which will burn at a sufficient rate on the available grate surface, and it must be a question for calculation how far it will pay to provide more grate surface to burn cheaper fuels, which also, as a rule, demand some special form of machine stoker. A table is given based on a coal costing $4.00 and evaporating 11 lbs. of water, and showing the annual saving to be made by inferior coals down to 7 lbs. evaporation and $0.50 cost. A middle example would be a coal at $2.00 with an efficiency of, say, 8 lbs. It would save $6,115 annually on a 1,000 H.P. plant. It would only cost about $250 to drive the fan, so that the saving would be close on $6,000 net. Apart from the power to burn cheaper fuels which is given by a fan, this method of draught production has the advantage of convenience and elasticity in bad weather. The draught can at once be suited to the demand for steam. It is, in fact, equivalent to having the power to open the damper of an ordinary boiler, say, 20 feet more than the ordinary maximum, and still find improvement of draught.

Dust and small fuel can probably be best dealt with by means of mechanical stokers, and probably this will prove some day a great help to water-tube boilers, for a satisfactory mechanical stoker, especially of the steeply sloped grate variety, cannot be applied to an internally fired boiler. The sloping grate brings into play gravity, and so far this action is alone capable of sufficiently consolidating the further parts of a fire. Externally fired boilers are much easier to provide with efficient mechanical stokers than boilers with internal furnaces, though they require special furnace forms to avoid smoke.

PHYSICAL SOCIETY.

Ordinary Meeting, January 27th, 1899.

Mr. G. Griffith, M.A., Vice-President, in the Chair.

A mathematical paper was read by Dr. E. H. Barton on "The Equivalent Resistance and Inductance of a Wire to an Oscillatory Discharge."

Maxwell's treatment of the self-induction of cylindrical conductors was extended by Lord Rayleigh, in an article published in the *Phil. Mag.* for May, 1886, to alternate currents that follow the harmonic law at constant amplitude. Dr. Barton now modifies the analysis and further extends it to include the decaying periodic currents obtained in discharging a condenser, and to the case of damped trains of high frequency, *i.e.*, to Hertz waves in general. The theoretical value (R''/R') for the ratio of equivalent resistance to waves, respectively with and without damping, agrees very well with Mr. Barton's experimental results.

Mr. Oliver Heaviside, in a communication (here abstracted), said that he had by another method of mathematical analysis arrived at the same value as Mr. Barton for (R''/R'). In addition to the causes hitherto suggested as affecting the attenuation factor, it was possible that the conductivity of the wires to vibrations millions per second, might be less than with steady currents, and that the voltage at the beginning of the wave train might be large enough to cause some leakage. Both resistance and inductance become infinite with infinite damping, and they differ somewhat from the corresponding quantities for undamped waves.

Mr. Rollo Appleyard then described (1) some experiments upon dephlegmators, in which he has attempted to replace the platinum gauze valves of the ordinary factionating tubes by bends in the tubes. Mr. Appleyard also exhibited (2) a temperature tell-tale, to be used in connection with vats and for other purposes where an alarm is to be sounded by making electric contact when temperature rises or falls beyond certain limits. A J-shaped glass tube has its short limb sealed and its long limb open. Water or other suitable liquid is poured in, completely filling the short limb. Mercury is then made to displace nearly all the water in the short limb; the surplus water in the long limb is removed by a pipette, and mercury is also adjusted to a convenient level. Two platinum contact-wires are sealed into the glass at a short distance above the free surface of mercury in the long limb. The tube may be half an inch in diameter, with a long limb of 5 inches, and a short limb of 2½ inches. The quantity of mercury in the tube is generally arranged so that at temperatures below the boiling point of the contained liquid, the mercury level is lowest in the long limb. In this case, if the temperature is raised to the boiling point of the contained liquid, the mercury assumes approximately a common level in both limbs, for at the boiling point of the liquid, under these conditions, the vapour-pressure is equal to the barometric pressure. Hence, the liquid and the mercury are not spurted out.

Mr. Whopple said that when working with an ordinary thermometer tube, the contacts were inefficient owing to oxidation. Moreover the mercury column broke up, and in some cases mercury clung to the contact wire. He asked if these difficulties occurred in Mr. Appleyard's apparatus.

Mr. Watson suggested that in some cases the long limit might, with advantage, be closed. With regard to the dephlegmator, he thought that the bends should each be duplicated by a short tube so as to provide one path for the descending liquid, and another for the ascending vapours. This seemed to be the object of the platinum gauze in fractionating tubes.

Mr. Appleyard, in reply, explained that the change of level in the "tell-tale" was a sudden rise of about an inch of mercury, in a tube half an inch in diameter. This rise was able completely to envelop the contact wires, surface oxidation could not affect the working, and there could be no such thing as failure of contact. Moreover, the tube was too wide for mercury to be held up by capillarity. The large area of contact enabled the instrument to be used for strong currents. The cost was small, and the only adjustment consisted in choosing a liquid of suitable boiling point; for the platinum wires could be sealed in anywhere in the long limb, about 2½ inches from the bottom was a good position for them. The sudden rise occurred when the temperature was one or two degrees above the boiling point of the contained liquid.

The meeting adjourned until February 10th (annual general meeting).

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

947. "Improvements in or relating to electrical furnaces for the production of calcium carbide and other substances." J. Bastick. Dated January 16th.

962. "Improvements in electric arc lamps." W. Crudgington. Dated January 16th.

974. "Improved prepayment electricity meter for continuous or direct currents, whose action depends on deposition of copper in a balance against silver coins." E. F. Tebbey and C. H. I. Phillips. Dated January 16th.

1,024. "Improvements in dynamometrical apparatus." H. Bourn. Dated January 16th. (*Complete.*)

1,044. "Improvements in switches for electro-motors and the like." R. A. Sloan and J. E. L. Barnes. Dated January 16th.

1,047. "Improved construction of straight and curved underground conduits for enclosing electric conductors, haulage cables, and other means of communication allowing connections of vehicles, sledges, and moving bodies to same and allowing access below." G. W. Sutcliffe. Dated January 17th.

1,063. "Improvements in the method of and means employed for controlling the trolleys of electric cars." W. W. Richardson. Dated January 17th.

1,087. "Improvements in electric heaters." F. W. Schindler. Dated January 17th.

1,100. "Improvements in electric light brackets." W. G. Wilson and P. S. Pilcher. Dated January 17th.

1,105. "Improvements in coin-freed electrical shocking machines." A. Campbell. Dated January 17th.

1,106. "Improvements in and relating to facia for electrical instruments." M. Byng and R. P. Eidsforth. Dated January 17th.

1,141. "A method of and some means for deriving two or more alternating currents of different phase from a source of single-phase electrical supply." H. A. Wagner. Dated January 17th.

1,147. "Improvements in or connected with electric arc lamps." W. J. Davy. Dated January 17th.

1,154. "Improvements in or relating to the regulation of pressure of electric circuits and apparatus therefore." L. W. Heath and J. H. Field. Dated January 18th.

1,156. "Improvements in current collecting apparatus for electric tramways." C. W. G. Little and A. J. Ireland. Dated January 18th.

1,179. "Improvements in the construction of dynamo-electric machines and motors." M. W. W. Mackie. Dated January 18th.

1,188. "Improvements in guards for overhead electric conductors, such as trolley wires and the like." P. L. Jones. Dated January 18th.

1,201. "Electric generator of heat." A. Westrop. Dated January 18th.

1,208. "Improved system of underground electric conductors." A. Sterza. Dated January 18th. (*Complete.*)

1,230. "Improvements in lighting trains by electricity." C. P. Elieson and W. S. Naylor. Dated January 18th.

1,232. "A process of and means for transforming 'electric currents.'" H. P. J. J. Thomsen. Dated January 18th. (*Complete.*)

1,233. "Improvements in arc lamps." F. J. Borland. Dated January 18th.

1,234. "Improvements in the electro-capillary treatment of woody and other fibre and apparatus therefor." A. L. C. Nodon and L. A. Bretonneau. Dated January 18th. (*Complete.*)

1,266. "Improvements in and connected with the manufacture of electrical cables or conductor conduits." A. Musker. Dated January 19th.

1,293. "Improvements on portable electric lamps." H. Nehmer and F. Nehmer. Dated January 19th.

1,324. "Improvements in and in the manufacture of electrode plates for electric accumulators." W. P. Thompson. (The Accumulatoren and Elektricitatswerke A. G. vorm. W. A. Boese and Co., Germany.) Dated January 19th. (*Complete.*)

1,334. "Improvements relating to electrically illuminated signs or advertisements." W. L. Campbell. Dated January 19th. (*Complete.*)

1,371. "Improvements in electrically governed feeding and drinking appliance for animals and live stock." C. Miles. Dated January 20th.

1,381. "Improved process in moulding, electrifying, and hardening castings to withstand intense heat, furnace bars for marine locomotive land boilers, other furnaces, and the like." J. S. Holme. Dated January 20th.

1,394. "Improved electric clock and general registering or equal power maintaining or discharging machine." J. J. Stockall. Dated January 20th.

1,427. "Improvements in and relating to primary batteries." W. Rowbotham. Dated January 20th.

1,431. "Improvements in supports for the active-material of accumulator electrodes." F. Wuste, F. von Rupprecht, and C. von Rupprecht. Dated January 20th. (*Complete.*)

1,434. "Improvements in telegraphic relays and to appliances for use in connection therewith." S. G. Brown. Dated January 21st.

1,439. "An electric lamp-hour meter." A. J. Howard and W. F. Howard. Dated January 21st.

1,483. "Improvements in and relating to automatic electric railway signalling." G. C. Marks. (I. Mazell, France.) Dated January 21st.

ELECTRICAL PATENTS OF 1885 EXPIRING IN FEBRUARY, 1899.

We are informed by Messrs. W. P. Thompson & Co., that about 90 applications for electrical patents were filed in the month of February, 1885. Out of these some were never completed, and of those that were only one has been allowed to run its full length of term, viz., 14 years, and being of considerable interest we give a short abstract below:—

1,737. "Improvements in the manufacture of metal tubes, cylinders, rings, and bars." F. Elmore. Dated February 7th, 1885. Making tubes, rods, rings, &c. Relates to the construction of cores or mandrels for copper tubes, &c., on which the metal is deposited by electrolysis, and which are capable of being used more than once. A core for which internal finish is required, is made of wood divided diagonally and provided with internal lugs, by which it is bolted together. In alternative arrangements, the core is divided in the plane of the axis, and is provided with intermediate filling pieces, which are withdrawn when it is required to extract the core to give both internal and external finish to a tube, the core and mould being attached to the base-plate. The mould may be corrugated if necessary, and may be designed to give external finish to the tubes. Cylinders, rings, rods, gas check rings, &c., for large projectiles, &c., may be made by this process. 2 claims.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free,* 9*d.* (*in stamps*).

1898.

10,690. "Improvements in starting devices for single-phase alternating electric current motors." British Thomson-Houston Company, Limited. (J. P. Stone and S. E. Doane). Dated May 10th, 1898. Relates to apparatus for starting single-phase alternating electric current motors. It consists of an alternator supplying the single-phase mains from which leads go directly to the motor terminals. Between these two leads the resistance and the inductance in the form of a compensator are connected in series, suitable switches being provided to disconnect the starting devices from the circuit. 3 claims.

10,900. "Improvements in electric arc lamps." W. L. Wise. (J. H. Hubbell.) Dated May 12th, 1898. Relates to electric arc lamps known as enclosed arc lamps, and consists of a frame with the feed magnets mounted on it. The side rods depend from this frame and support the base plate. The lower carbon holder consists of a socket having a flaring seat at its upper end and externally screw threaded at its lower end for suitable nuts. The clamping tube has a conical exterior at its upper end and is fitted to the flaring socket, and has a thumbscrew turned upon its lower end. The arc enclosing cylinder rests preferably upon a ring removably inserted in the base plate. The upper carbon holder consists in the main of a ring clutch, a hoop, and a yoke connecting the solenoid cores, and the solenoid for operating the cores. 21 claims.

10,901. "Improved system for producing luminous effects, Röntgen rays, or similar electrical effects, and apparatus for use therein." W. L. Wise. (Moore Electric Company.) Relates to a system for producing luminous effects, waves or disturbances generated by repeatedly interrupting a circuit of self-induction, the electromotive forces or disturbances thereby generated being utilised directly in another circuit or path, termed a working circuit, to produce the desired effect by means of a vacuum tube or similar device. 26 claims.

11,518. "Improvements in electrical lighting devices for kerosene and other burners." S. M. Meyer. Dated May 20th, 1898. The subject of this invention is a device for lighting the wick of a kerosene or other lamp by means of an electric spark. Consists of a suitable lamp body, a burner separable therefrom, a source of electricity in the body or base of the lamp grounded by one pole in the lamp body, an insulated conductor from the other pole, an igniting device mounted on the removable burner grounded by one end in the metal of the burner and connected at the other end with an insulated conductor, insulated contact devices carried by the lamp body and removable burner respectively, and respectively connected to the insulated conductors therein, so as to form electric connection between the insulated conductors when the burner is placed in position and a suitable device for closing the electric circuit by hand. 10 claims.

12,322. "Improvements in electric batteries." E. Edmunds. (P. A. Emanuel.) Dated June 1st, 1898. Relates to improvements in electric batteries especially of the type arranged to accumulate the effects of dynamical electricity and strengthening the same. Consists in employing a vessel having a plurality of openings at its top and bottom, connecting the said openings at one end of the vessel with those at the other by porous tubes, which therefore pass longitudinally through the vessel and locating a voltaic pile within each of the tubes. The porous tubes are surrounded by an electrolyte. Below this vessel is located another vessel similar in construction to the first, except that the porous tubes are of much smaller bore, and do not carry any piles. The two sets of porous tubes are in a straight line. The tubes in the lower vessel are surrounded by water. Steam is passed into the tubes of the lower vessel and up through them into expanding chambers provided with points against which particles of water, charged with electricity, impinge, and which, therefore, collect some of the electricity generated by the partially condensed steam passing up the tubes. The partially condensed steam is then forced on up a central channel in the piles and passes through them and out at the top of the battery. The steam in passing through the channels of the piles creates a partial vacuum therein which causes the electrolyte to more readily flow toward the centre of the piles, and therefore come into more intimate contact with the elements. 20 claims.

13,210. "Improvements in, and relating to, electric heaters." R. Lundell. Dated June 13th, 1898. Relates to the "Dewey heater," as described in Specification No. 5,595 of 1891. It consists of a fan driven by an electric motor, thereby diffusing and radiating the heat rising from the heater all over the room. The fan is protected by a guard, and the heater is fixed to this. The heater consists of several heat developing resistances insulated by porcelain rods, which are held in position by two grooves into which two rods fit. 8 claims.